INDIANA'S WATER SHORTAGE PLAN

INDIANA DEPARTMENT OF NATURAL RESOURCES, DIVISION OF WATER

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I. Introduction

Indiana has experienced droughts of varying severity in the past; however, the drought of 1988 focused attention on the widespread impacts of such a natural disaster and the need to have a plan to minimize the negative effects of the disaster and maximize the positive response to it.

In 1991 the Indiana General Assembly enacted House Bill 1260, codified as Indiana Code 13-2-6.1-10 (since repealed) which required that the Indiana Department of Natural Resources develop a plan to meet the needs of the citizens and environment of Indiana when the shortage of water threatens (1) the health, safety, welfare, or economic well-being of the citizens; or (2) the environment; of any part of Indiana. The statute mandates that the Department consider specific items including:

1) Criteria for identifying
    a) the onset of a water shortage; and
    b) various stages of severity of a water shortage

2) Establishment of relative priorities of water uses in various stages of a water shortage.

3) Provisions authorizing increased groundwater withdrawals, the use of a part of minimum ~~stream flows~~ streamflow, use of water stored in lakes and reservoirs and water conservation programs.

In 2006 the Indiana General Assembly enacted Senate Bill 369, codified as Indiana Code 14-25-14 which required the Director of the Indiana Department of Natural Resources to appoint a Water Shortage Task Force (WSTF). The ten-member WSTF was charged with developing and implementing an updated water shortage plan and to address other surface water and ground water issues.

II. Purpose

The purpose of this plan is to provide the State of Indiana with an effective and systematic plan to assess and manage the State's water resources during a water shortage or potential water shortage to respond, to the maximum extent practicable, to the needs of its water users while protecting its environment. It is intended to serve as a tool for the State of Indiana to guide the use and management of the state's water resource as the availability of that resource diminishes during events such as drought. While portions of the plan may be utilized to address localized water shortages caused by isolated events (i.e. loss of a primary well or wells or a reservoir dropping to critical levels) it is presumed that the document will be most useful in addressing regional water shortages which typically result from drought events.

This document is intended to provide a plan of response as a water shortage develops. It should be noted that efficiency of use and conservation are topics which have received little attention in the past in the state of Indiana. Efficient water supply systems and

conservation measures will reduce the demand on the resource and assist in minimizing the impacts of a water shortage on the State's citizens.

Efforts to promote efficiency and encourage conservation of water are therefore, a planning tool which would be preferable to attempting to balance the needs and wants of water users in times of water shortage. Therefore, as a first step to planning for water shortage, the State of Indiana should encourage, support, and promote both water conservation and efficient use of its water resource. Information concerning water conservation is included in Section V, and a suggested ordinance for the conservation and rationing of water furnished by a public water supply system is included in Appendix III of this report.

I. Water Shortage Task Force

For purposes of updating and administering this plan, ~~it is recommended that~~ a Water Shortage Task Force ~~be~~ was created (IC 14-25-14, Appendix I). The Task Force will assume the role of policy coordination during times of water shortage, reviewing and recommending alternative policy response options to the Governor. The ten-member task force ~~should include representatives from the most relevant agencies within government and should include other representatives with expertise in the field of water use and/or management. Included in the make-up should be representatives with expertise and/or knowledge of instream uses. It is recommended that the task force be created legislatively with a mandate to meet annually or semi-annually. Required meetings will assist in developing awareness, coordination and cooperation in the event that a water shortage does occur. Since statewide response to a water shortage may extend to sectors not related with the water resource, the task force may best be chaired by the Governor, Lieutenant Governor or their appointee.~~ consists of a representative from each of the following: public water supply utilities, agriculture; steam electric generating utilities; industrial users; academic experts; municipalities; environmentalists, consumer advocates; economic development advocates; and the public. Each of the following state agencies designated a representative to advise the task force: ~~Membership of the task force should include representatives of the State Emergency Management Agency (SEMA)~~ the Department of Homeland Security (IDHS), the Department of Natural Resources (DNR), the ~~Indiana~~ Department of Environmental Management (IDEM), the Department ~~Officer of the Commissioner~~ of Agriculture (ISDA), ~~Utility Regulatory Commission (URC),~~ and the ~~Indiana~~ Department of Health (ISDH) ~~(IDOH) and a representative of each major water/interest group identified in the plan~~. Representatives from several additional entities were invited to also advise the task force. The WSTF members are listed in Appendix II along with the advisory representatives. It is recommended that as the water shortage develops and decisions must be made in various affected regions, advisory membership ~~of~~ to the task force be expanded to include local input from area water users. Area representatives should either be water interest groups, local elected officials or a combination of the two. Upon declaration of a water shortage emergency, regional input shall be sought by the Task Force to identify priority uses in the affected region prior to determining any mandatory restrictions which might be implemented in a region.

IV. Definition of Water Shortage

The enabling legislation refers to the development of a water shortage plan since the Legislature recognized that water shortages could occur for a variety of reasons including drought, catastrophic occurrences, increased demand, lack of planning, etc. Typically drought is the most recognized cause of a water shortage and can impact users in a large geographical region. Because drought is a natural climatic event and their recurrence is inevitable, much work has been done to develop criteria to identify the onset and severity of drought and to plan response actions to the various stages of drought. Of the many definitions of drought, the legislative intent appears to include a water management drought which characterizes water deficits resulting from water management practices or facilities. Therefore, for purposes of this plan, water shortage refers to a limitation of the water supply resulting from natural phenomenon such as drought and problems of water distribution and use.

V. Water Conservation Measures

As noted previously, efforts to promote efficient water use and encourage conservation of water are a planning tool which would be preferable to attempting to balance the needs and wants of water users in times of water shortage. Effective water conservation involves the entire community and consists of many of the following basic steps.

A. Individuals

1. Find and fix water leaks. Check all water-using appliances, equipment and other devices for leaks. A leaking toilet can waste 200 gallons per day. Running toilets, steady faucet drips, home water treatment units, and outdoor sprinkler systems are common sources of leaks.

2. Install water-efficient plumbing fixtures. A major water use inside the home is toilet flushing. A high-efficiency toilet that uses 1.6 gallons or less per flush can save a family of four from wasting 14,000 to 25,000 gallons of water per year. Install low-flow faucets aerators and showerheads; consider purchasing a high efficiency washing machine which can save fifty percent in laundry water and energy use.

3. Eliminate wasteful water habits, such as running the dishwasher or clothes washer when only half full or allowing unused water to run; use the appropriate load size selection on the washing machine. When using a hose, control the flow with an automatic shut-off nozzle. Wash the car with water from a bucket, or consider using a commercial car wash that recycles water.

4. Improve outdoor water efficiency by using proper irrigation and scheduling techniques, e.g. water in the cooler parts of the day or use cycling sprinklers. Choose landscaping that requires little water, and only water the lawn every three to five days in the summer. Use soaker hoses or trickle irrigation systems for trees and shrubs; and install moisture sensors on sprinkler systems. Use a broom, rather

than a hose, to clean sidewalks and driveways. Lower the water level in pools to reduce the amount of water splashed out; and use a pool cover to reduce evaporation when the pool is not in use.

5. Cut back on non-essential uses, e.g. washing one's car or using running water to thaw frozen food (thaw in refrigerator overnight). Avoid recreational water toys which require a constant stream of water. Operate ornamental water features only if they recycle the water.

6. Reuse water for non-drinking purposes. Before pouring water down the drain, consider other uses for it, such as watering plants or garden.

B. Water and Wastewater Utilities

1. Meter all water users.

2. Charge for water and sewer service based on the amount used.

3. Charge more for water and sewer service per unit, as use increases, if approved by the Utility Regulatory Commission (URC) to ensure the utility rate structure encourages water efficiency, or at least does not discourage it.

4. Increase billing frequency to increase awareness of use; use water bills as components of an information and education program to educate water users about the costs involved in supplying drinking water, and to demonstrate how water conservation practices will provide water users with long term savings; gaining public support for a utility's water conservation program.

5. Charge more for water during seasons of peak use, if approved by the URC.

6. Develop a water efficiency plan; consider a reclaimed wastewater distribution system for non-potable uses.

7. Develop a water-loss management program to examine the water distribution system for leaks at regular intervals, and repair leaks promptly. The water industry goal for unaccounted-for-water is 10 percent.

8. Reduce excessive water pressure in the distribution system, e.g. system wide pressure management, flow restrictors, and pressure-reducing valves.

9. Conduct water-use audits of homes, businesses, and industries. Audits provide users with information about their water habits and how usage might be reduced by implementation of specific voluntary measures.

10. Make retrofit kits for residences available free or at cost. Kits may contain low flow faucet aerators, high efficiency showerheads, leak detection tablets, and replacement valves.

C. Local Government

1. Adopt water-efficient plumbing, landscaping, and building codes.

2. Develop a program to replace or retrofit water-wasting plumbing fixtures in existing buildings.

3. Reduce municipal water use, e.g. plant water efficient vegetation and install high efficiency plumbing products on city property; set a good example.

4. Educate water users about conservation; develop public outreach and education programs for the public to increase conservation awareness.

5. Promote water efficient landscape practices for homeowners and businesses, especially those with large, irrigated properties. Practices include use of native plants, landscape renovation to reduce water use, and more efficient irrigation.

D. State Government

1. Require conservation as part of water supply grants and loans.

2. Adopt a state wide plumbing code for water use efficiency.

3. Promote water conservation in state facilities; develop a program to replace or retrofit water wasting plumbing fixtures in state owned buildings.

4. Include conservation measures as a condition for issuing state contracts, permits or licenses for water or wetlands development.

5. Offer incentive programs (rebates/tax credits) to homeowners and businesses to encourage replacement of plumbing fixtures and appliances with water-efficient models.

6. Educate water users about conservation; develop public outreach and education programs to increase conservation awareness.

E. Benefits of Water Conservation

Saving water provides benefits for the environment and for the community. Water Conservation benefits all communities, even if they have a stable and sufficient water supply. Efficient use of water can help prevent pollution, protect aquatic ecosystems, conserve energy resources, and save substantial amounts of money, among other benefits.

1. Using less water reduces the burden on wastewater treatment plants and septic systems, improving the quality of our lakes, rivers, and marine waters.

2. Diverting less water from our rivers and lakes helps maintain a healthy aquatic

environment. Building fewer and smaller water supply projects can help preserve wetlands that naturally filter pollutants.

3. Water efficiency means less energy is used to pump, treat, and heat water.

4. Conserving water may be quicker and cheaper than developing a new water supply.

VI. Water Shortage ~~Contingency~~ Identification Plan Phases and Restrictions

A. General

Using the recommendations discussed in following Sections, this Section sets forth water shortage response actions to be undertaken by various State and local agencies, public water supply systems, and users under various stages of water shortage conditions. The declaration of water shortage stages, and actions taken in response to such conditions, may be undertaken for the entire State, for one or more of the Water Shortage ~~Contingency~~ Identification Regions of the state (as shown in Figure 1) or for one or more areas or localities as dictated by the criteria described in Section IX(D).

The overall objective of this plan is to identify and establish management responsibilities and actions to be taken at various stages of a water shortage in order to assure: (1) protection of public health, safety, and welfare; (2) preservation of essential water uses; (3) equitable sharing of available supplies; and (4) conservation of water resources. As suggested in Section II previously, the promotion of conservation measures and efficient use of the resource at all levels when no water shortage exists would help minimize the impact on the State's water users when such an event occurs. Such practices may also extend the time between declaration of the various phases discussed below. **The plan is designed to establish a staged phasing of water shortage response actions in order to allow orderly and coordinated preparation for, and implementation of, conservation measures and other necessary actions as conditions worsen, and to provide for appropriate relief and relaxation of use restrictions as conditions improve.**

The response actions, conservation measures and water use restrictions specified in this plan may be modified by the Governor, the State Emergency Management Agency acting in consultation with the Indiana Department of Natural Resources, Department of Environmental Management and other agencies as necessary to respond to changing conditions and to achieve water use reductions determined to be necessary under the circumstances.

~~Figure 1. Indiana Counties and Water Management Basins.~~

Figure 1. National Weather Service Climate Divisions of Indiana (Water Shortage Identification Regions).

B. Definitions

1. "Department" means the Department of Natural Resources.

2. "Task Force" means the Water Shortage Task Force as might be created pursuant to the recommendation in Section III of this report.

3. "Water Shortage ~~Contingency~~ Identification Regions" means the ~~twelve Water Management Basins~~ nine climate divisions determined by the National Weather Service (shown in Figure 1) ~~developed for conducting Indiana's water resource assessments as required by IC 14-25-7-11(1)~~.

4. "Water Shortage Stages" for the purposes of this plan means the four stages that are designated based on the value of the Standardized Precipitation Index (SPI), the U.S. Drought Monitor, and below normal percentiles of regionalized monthly average streamflow. The stage is defined as Normal if no more than one indicator is outside of the normal range. The stages and their associated criteria are listed in Table 1.

Table 1. Criteria to Identify Drought Conditions and Water Shortage Stages

Water Shortage Stages	1-Month Standardized Precipitation Index[1]	U.S. Drought Monitor[2] (Conditions)	Streamflow As Percentile Of Normal[3] (Average Streamflow)
Normal (White and Yellow)	+0.99 to -0.99	None to D0	Greater than or equal to 25
Watch (Tan)	-1.00 to -1.49	D1	10 to 24
Warning (Orange)	-1.50 to -1.99	D2	6 to 9
Emergency (Red)	-2.00 or less	D3 to D4	5 or less

[1]For the purposes of Indiana's Water Shortage Plan, a monthly SPI value is computed for each of the state's nine climatic regions. For more detail, see the Standardized Precipitation discussion.
[2]The data cutoff for Drought Monitor maps is Tuesday at 7 a.m. Eastern Standard Time. The maps, which are based on analysis of the data, are released each Thursday at 8:30 a.m. Eastern Time. The map released the first Thursday of the month will be used as a drought indicator for the previous month's water shortage stages. ~~The U.S. Drought Monitor map will be used on an interim basis for the purpose of defining drought within the State of Indiana. The action plan will be triggered for a county when any part of a county is defined as having drought conditions.~~ For more detail, see the U.S. Drought Monitor discussion.
[3]Streamflow at the 25th percentile means that streamflow is only 25% of the historical average streamflow for that particular month. Lower percentiles correspond to increasingly lower streamflow and drought conditions. For more detail, see the streamflow discussion.

C. Phase 1: Water Shortage Watch

1. Objective

The objective of the watch stage is to alert government agencies, public water supply systems, and the public regarding the onset of conditions indicating the potential for future water shortage problems. The focus of this stage is increased monitoring, awareness and preparation for response to water shortage conditions should conditions worsen. The objective of voluntary water conservation measures during this stage is an overall reduction in water use of 5% in the affected areas.

2. Declaration

   a. When, a Water Shortage Watch is indicated for the entire state, a region, area or locality, the Department shall advise the Governor, Lieutenant Governor, and the Executive Director of the ~~State Emergency Management Agency (SEMA)~~ Indiana Department of Homeland Security (IDHS) of such conditions.

   b. IDHS will advise the members of the Water Shortage Task Force and other appropriate State agencies of the onset of such conditions.

   c. The Department, in consultation with IDHS, will issue press releases and other notification to the media as it deems appropriate to advise the public of the potential onset of water shortage conditions.

   d. The Department, as it deems appropriate, will consult with the Drinking Water Branch of the Indiana Department of Environmental Management (IDEM), and advise public water supply systems in the affected area by telephone or letter regarding the onset and declaration of watch conditions.

3. Response Actions

   a. The Department will initiate and maintain increased monitoring of climatic, hydrologic, and water supply conditions in the affected area.

   b. The Department, in conjunction with the Drinking Water Branch of IDEM will review and contact, as appropriate, public water supply systems in the affected area to ascertain the status of water supply availability and demand, and will identify systems which may be confronted with an insufficient water supply source or other problems, particularly in the early part of the water shortage.

   c. The Department will advise the Governor, IDHS and other state agencies regarding the progress of conditions through reports issued on a bi-weekly basis.

   d. IDHS, in consultation with the Department, will convene the Water Shortage Task Force to review responsibilities under this plan and to coordinate any necessary preparations for response actions.

   e. The Department will, as it deems appropriate, issue advisories to the public encouraging voluntary conservation measures of the type specified below under "Water Conservation Program".

4. Water Conservation Program - Water Shortage Watch

The following voluntary water conservation measures and programs will be encouraged during the watch stage:

   a. Domestic and Other Sanitary Uses

The Department and public water supply systems should step-up public education programs concerning the reduction of in-home domestic use by implementing water conserving measures and installing water conserving devices. Additional recommendations may apply for outdoor irrigation use as outlined in Item f.

(1) Inside and outside aesthetic uses of water (i.e. lawn watering) should be voluntarily reduced.

(2) Water used for washing and/or flushing streets, driveways, and other impervious areas should be voluntarily reduced.

(3) Water used for recreation should be voluntarily reduced.

(4) Water used for outside pressure cleaning should be voluntarily reduced.

(5) The use of water for automobile and other mobile equipment washing, including boats and trailers, should be voluntarily reduced.

(6) The use of water for cooling and air conditioning should be voluntarily reduced.

b. Essential Service Use

(1) Fire hydrant flushing should be undertaken only as necessary for protecting human health, safety, and welfare. Fire departments and other agencies should exercise restraint and review maintenance schedules in light of the water shortage watch conditions.

(2) Sanitary sewer line flushing and testing should be restricted to those activities necessary for protecting human health, safety, and welfare and proper functioning of the system. Sewage system operators should exercise restraint and review maintenance schedules in light of water shortage watch conditions.

c. Public Water Supply System Use

(1) Public water supply systems should continue to initiate or consider initiating all reasonable conservation measures including improving and accelerating leak detection surveys and repair programs, installing and calibrating meters, and other water saving measures that may be appropriate.

(2) Water shortage contingency plans should be developed by those public water supply systems which do not have such plans available for implementation if the water shortage should continue.

(3) Public water supply systems should enact an ordinance enabling them to conserve and ration water as necessary.

d. Industrial and Commercial Use

(1) Recycled water should be voluntarily used wherever possible to reduce freshwater use.

(2) Users should initiate or continue conservation measures, such as employee education and installing water conserving devices, to reduce freshwater use for domestic and sanitary purposes.

(3) Users of water for commercial and industrial processes should begin planning for voluntary reductions in water use where feasible, and initiate contingency planning for reduction of non-essential uses, plant and equipment cleaning, water-cooled air conditioning, lawn irrigation, and other freshwater uses where applicable. Additionally, programs to reduce leakage and loss of water should be initiated.

e. Institutional Use

Water use should be voluntarily reduced by implementing water conservation techniques. Large institutions (such as schools, colleges, nursing homes, and correctional facilities) should reduce outside uses, implement leak reduction measures, and undertake installation of water saving plumbing devices.

f. Irrigation Use

Current use of irrigation water should be voluntarily reduced by 5% whenever possible and managed to reduce freshwater consumptive use. Drip or trickle irrigation systems should be used where possible.

g. Livestock and Poultry Water

Use should be voluntarily reduced whenever possible.

h. Miscellaneous Uses

(1) Inside and outside aesthetic uses of water should be voluntarily reduced.

(2) Water used for washing and/or flushing streets, driveways, and other impervious areas should be voluntarily reduced, unless necessary to protect public health and safety.

(3) Water used for recreation should be voluntarily reduced.

(4) Water used for outside pressure cleaning should be voluntarily reduced.

(5) The use of water for automobile and other non-commercial mobile equipment washing, including boats and trailers, should be voluntarily reduced. Users should be encouraged to use facilities which utilize water recycling equipment, or to use hand-held hoses equipped with automatic shut-off nozzles.

(6) Water should be served in public and private places of eating only if specifically requested by a customer.

(7) The use of water for cooling and air conditioning should be voluntarily reduced.

D. Phase II: Water Shortage Warning

1. Objective

The objectives of the warning stage are to prepare for a coordinated response to imminent water shortage conditions and potential water supply problems and to initiate concerted voluntary conservation measures in an effort to avoid or reduce shortages, relieve stressed sources, and if possible forestall the need for mandatory water use restrictions. The objective of water conservation efforts during this stage is a reduction in current water use of 10-15% in the affected area.

2. Declaration

a. When a Water Shortage Warning is indicated for the entire State, a region, area, or locality, the Department shall advise the Governor, Lieutenant Governor and the Director of IDHS of such conditions. The Department and IDHS jointly will declare the water shortage warning stage.

b. IDHS will advise the members of the Task Force and other appropriate State agencies of the onset of water shortage warning conditions.

c. The Department, in consultation with IDHS and the Governor's Office, will issue press releases and other notifications to the media to advise the public of the declaration of a warning and potential for impending water supply problems.

d. The Department, in conjunction with the Drinking Water Branch of IDEM, will advise public water supply systems in the affected area by telephone or letter regarding the declaration of a Warning.

e. The Department, through the Division of Water will advise the owners of all registered high capacity water withdrawal facilities in the affected area by telephone or letter regarding the onset and declaration of watch conditions.

3. Response Actions

a. The Department will maintain increased monitoring of climatic, hydrologic and water supply conditions in the affected area.

b. The Director of the Department of Natural Resources, in consultation with the Governor and the Director of IDHS, will appoint an officer of the Department to serve as Water Shortage Coordinator. The Water Shortage Coordinator will be responsible for:

(1) Coordinating, supervising and directing the preparations and response

actions of all Department offices involved in water shortage management activities.

(2) Serving as lead liaison and advisor to the Task Force, IDHS and other State agencies regarding water shortage conditions and response actions.

(3) Assisting the Director and staff of IDHS in coordinating and directing water shortage response actions by all involved State agencies.

c. The Department, in conjunction with the Drinking Water Branch of IDEM, will survey public water supply systems in the affected area in order to ascertain the status of water supply availability and demand.

d. The Department in conjunction with the Drinking Water Branch of IDEM, will identify public water supply systems which are faced with significant risks for developing water shortage or other problems, and will at least every two weeks continue to survey the status of such systems. The Department, in conjunction with IDHS, will initiate steps to identify potential emergency sources of water and other response actions which may be needed to address problems encountered by such systems and will advise the system operator, and where appropriate, the Utility Regulatory Commission (URC) regarding actions which should be taken to avoid or respond to potential problems.

e. The Department will advise the Governor, the Director of IDHS, and other State agencies regarding the progress of conditions through reports issued on at least a weekly basis.

f. IDHS, in consultation with the Department, will convene the Water Shortage Task Force to focus plans and preparations for possible imminent implementation of the Indiana Water Shortage Plan and to coordinate ongoing actions in response to current conditions.

g. The Department, in conjunction with IDEM, will advise public water supply systems to immediately develop and update water shortage contingency plans for their respective systems, where such plans are not already available for implementation.

h. The Department and IDHS, through press releases, the Indiana Department of Commerce, Utility Regulatory Commission or other available means, may advise large industrial, commercial and power plant water users to prepare water shortage contingency actions for reducing their respective water use depending on the seriousness of water shortage conditions encountered in the affected area.

i. The Department, in conjunction with IDHS, through the Division of Public Information, will issue advisories to the public and various categories of water users encouraging voluntary conservation measures of the type specified below under “Conservation Program”.

j. The Department, in conjunction with the Utility Regulatory Commission, will meet with representatives of the Electrical Generating Facilities to discuss contingency planning if the water shortage continues.

4. Water Conservation Program - Water Shortage Warning

The following voluntary water conservation measures and programs will be actively promoted and implemented during the water shortage warning stage:

a. Domestic and Other Sanitary Uses

The Department, municipalities, and public water supply systems should step-up public education programs concerning the reduction of in-home domestic use by implementing water conserving measures and installing water conserving devices. Municipalities and public water supply systems should make concerted efforts to advise the public and consumers of the need for early conservation efforts in light of water shortage warning conditions. Additional restrictions may apply for outdoor irrigation use as outlined in Item f.

(1) Inside and outside aesthetic uses (i.e. lawn watering) of water should be voluntarily reduced.

(2) Water used for washing and/or flushing streets, driveways, and other impervious areas should be voluntarily reduced.

(3) Water used for recreation should be voluntarily reduced.

(4) Water used for outside pressure cleaning should be voluntarily reduced.

(5) The use of water for automobile and other mobile equipment washing, including boats and trailers, should be voluntarily reduced.

(6) The use of water for cooling and air conditioning should be voluntarily reduced.

b. Essential Service Use

(1) Fire hydrant use should be voluntarily reduced to fire fighting only; other uses of hydrants and hydrant flushing should be eliminated unless necessary to protect human health, safety, and welfare.

(2) Sanitary sewer line flushing and testing should be restricted on a voluntary basis to those activities necessary to protect human health, safety and welfare. System operators should exercise restraint and review maintenance schedules in light of water shortage warning conditions.

c. Public Water Supply System Use

(1) Public water supply systems should continue implementing conservation measures, including improving and accelerating leak detection surveys and repair programs, installing and calibrating meters, and other water saving measures that may be appropriate.

(2) New water line flushing and disinfection should be voluntarily reduced to minimum levels necessary to protect public health and safety.

d. Industrial and Commercial Use

(1) Recycled water should be voluntarily used wherever possible to reduce freshwater use.

(2) Users should continue conservation measures to reduce freshwater use for domestic and sanitary purposes.

(3) Water used for commercial and industrial processes should be voluntarily reduced.

(4) Users should voluntarily reduce nonessential uses, plant and equipment cleaning water-cooled air conditioning, lawn irrigation, and other freshwater uses where applicable.

e. Institutional Use

Water use should be voluntarily reduced by implementing water conservation techniques. Accelerated efforts should be taken by residential and other large institutions to install water saving plumbing devices.

f. Irrigation Use

(1) Current agricultural irrigation utilizing surface water sources should be voluntarily reduced by 10 to 15%, and when possible, conducted during non-peak evaporation and evapotranspiration hours, preferably after 5:00 p.m. and prior to 9:00 a.m. Irrigation should be avoided under conditions of high wind.

(2) Small scale agricultural irrigation utilizing surface water sources or water from a public water supply system should be voluntarily reduced. Irrigation utilizing water from a public water supply system should be limited to non-peak water usage hours.

(3) Landscape irrigation of new and existing installations utilizing surface water sources or water from a public water utility should be voluntarily reduced. Irrigation utilizing water from a public water system should be limited to non-peak water usage hours, using a handheld hose equipped with an automatic shut-off nozzle or a hand-held container for smaller areas.

(4) Inside and outside irrigation of nurseries utilizing surface water sources or water from a public water system should be voluntarily reduced. Irrigation utilizing water from a public water system should be limited to non-peak water usage hours.

(5) Irrigation of golf course fairways, roughs, and non-play areas utilizing surface

water sources or water from a public water utility should be voluntarily eliminated. Irrigation of greens and tees utilizing water from a public water system should be limited to non-peak water usage hours.

(6) Irrigation of existing and new recreation areas utilizing surface water sources or water from a public water supply system shall be voluntarily reduced. Irrigation utilizing water from a public water system should be limited to non-peak water usage hours.

(7) Irrigation of gardens, trees, shrubs and other plants, except by a hand-held hose equipped with an automatic shut-off nozzle or container utilizing water from a public water supply system, should be voluntarily limited to non-peak water usage hours.

(8) Treated wastewater irrigation should be encouraged, upon approval of IDEM.

(9) Freshwater used for irrigation should be applied at a minimum rate when possible.

g. Livestock and Poultry Water

Use shall be voluntarily reduced whenever possible.

h. Miscellaneous Uses

(1) Inside and outside aesthetic uses of water should be voluntarily eliminated except where water is recycled.

(2) Water used for washing and/or flushing streets, driveways, and other impervious areas should be voluntarily eliminated unless necessary to protect public health and safety.

(3) Water used for recreation should be voluntarily reduced and the use of water for refilling swimming pools and ice skating rinks after draining should be voluntarily eliminated.

(4) The use of water for outside pressure cleaning should be voluntarily reduced.

(5) The use of water for automobile and other non-commercial mobile equipment washing, including boats and trailers, by means other than facilities which utilize water recycling equipment, or by a bucket, pail or hand-held hose equipped with an automatic shut-off nozzle, should be voluntarily eliminated.

(6) Water should be served in public and private places of eating only if specifically requested by a customer.

(7) The practice of regularly draining and refilling air conditioning cooling towers in order to provide cool water for system operations should be voluntarily eliminated.

(8) The use of water for cooling and air conditioning should be voluntarily reduced

through means such as increasing minimum air conditioning temperatures and thermostat settings. Public education concerning the need to reduce demand on public water supplies and electric generating facilities must be stressed.

E. Phase III: Water Shortage Emergency

1. Objective

The objectives of management during a water shortage emergency stage are to marshal all available resources to respond to actual emergency conditions, to avoid depletion of water resources, to assure at least minimum water supplies to protect public health and safety, to support essential and high priority water uses and to avoid unnecessary economic dislocations. The objectives of mandatory water use restrictions and other conservation measures during this stage are to reduce consumptive water use in the affected area by at least 15%, and to reduce total use to the extent necessary to preserve public water system supplies, minimum ~~stream flows~~ streamflow, to avoid or mitigate local or area shortages, and to assure equitable sharing of limited supplies.

2. Declaration

a. When a Water Shortage Emergency is indicated for the entire State, a region, area, or locality, the Department will advise the Governor, Lieutenant Governor and the Executive Director of IDHS of such conditions. The Department and IDHS will immediately submit to the Governor a water shortage emergency proclamation for the affected region(s). As warranted by conditions, the Governor, pursuant to his authority under ~~IC 10-4-1~~ IC 10-14-3, will consider and issue a proclamation declaring a state of water shortage emergency for the affected area(s).

b. IDHS will immediately advise the members of the Task Force and other appropriate State agencies, and a regular or emergency meeting of the Task Force will be scheduled for the earliest possible date to take such actions as necessary to implement the provisions of the State Water Shortage Plan and coordinate other response actions.

c. IC 10-14-3, known as the Emergency Management and Disaster Law, confers upon the Governor emergency powers "because of the existing and increasing possibility of disasters or emergencies of unprecedented size and destructiveness that may result from manmade or natural causes, to ensure that Indiana will be adequately prepared to deal with disasters or emergencies, or to prevent or mitigate those disasters where possible, generally to provide for the common defense, to protect the public peace, health, and safety, and to preserve the lives and property of the people of the state..." IC 10-14-3-7 (a). A disaster is defined as an "occurrence or imminent threat of widespread or severe damage, injury, or loss of life or property resulting from any natural phenomenon or human act, including but not limited to fire, flood, earthquake, windstorm, ...(or) drought..." IC 10-14-3-1 (b). "The governor shall declare a disaster emergency by executive order or proclamation if the governor determines that a disaster has occurred or that the occurrence or the threat of a disaster is imminent" IC 10-14-3-12. In performing his duties under this law, "the governor may make, amend, and rescind the necessary orders, rules, and regulations to carry out (its) provisions" IC 10-14-3-11 (b)(1).

d. IDHS will advise county and local emergency management coordinators in the affected area of the declaration of a water shortage emergency.

e. The Department, in consultation with IDHS and the Governor's Office, will issue press releases and other notifications to the media to advise the public of the declaration of a water shortage emergency and impending or existing water supply problems.

f. The Department, through the Drinking Water Branch of IDEM, will advise public water supply systems and county and regional water management agencies in the affected area by telephone or letter regarding the declaration of water shortage emergency conditions.

g. The Department and IDHS, in conjunction with the Task Force, shall attempt to develop recommendations for the Governor regarding possible water use decisions as the severity of the water shortage increases.

3. Response Actions

a. The Department will maintain increased monitoring of climatic, hydrologic and water supply conditions in the affected area(s).

b. The Department, through the Drinking Water Branch of IDEM, will continue to survey public water supply systems in the affected area in order to ascertain the status of water supply availability and demand.

c. The Department, in consultation with IDEM, will identify public water supply systems which confront significant risks for developing water shortages and will, on weekly basis, continue to survey the status of such systems. The Department and IDHS will continue to identify potential emergency sources of water and other response actions which may be needed to address problems encountered by such systems, and will advise the system operator, where appropriate, regarding actions which should be taken to avoid or respond to potential problems. IDEM will be consulted concerning the need to issue emergency permits for the siting and construction of new public water supply wells if necessary.

d. The Department, through the Drought Coordinator, will advise the Governor, IDHS, and other State agencies regarding the progress of conditions through reports issued on at least a weekly basis.

e. IDHS, in consultation with the Department, will convene the Water Shortage Task Force as necessary to coordinate the response actions of involved State agencies.

f. The Department, through the Division of Public Information, and in conjunction with IDHS, will maintain a public media campaign to encourage implementation of all reasonable conservation measures. The campaign will include press releases, briefings, public service announcements, regular advisories to media weather announcers and news staff, and distribution of materials through water utilities and educational institutions.

4. Conservation Program - Water Shortage Emergency

a. Non-Essential Uses

The Task Force will recommend to the Governor to adopt and put into effect emergency regulations restricting non-essential water uses in the affected area. The Task Force may from time-to-time, and as conditions warrant, recommend the amendment of such regulations to respond to actual conditions, and may recommend the adoption of more or less stringent restrictions applicable to all or part of the affected area depending on drought and water shortage conditions and actual conservation achieved.

b. Domestic and Other Sanitary Uses

(1) The Department and public water supply systems should acquire and distribute information on the availability of packaged kits of water conservation devices which may be installed by domestic consumers. Such distributions will be targeted on a priority basis to public water supply systems and private self-supplied domestic users who confront the highest risks of depleted supplies.

(2) Non-essential use regulations recommended by the Task Force will be enforced by public water supply utilities and local law enforcement agencies, with technical assistance and advice from the Department.

c. Essential Service Use

(1) The non-essential use regulations recommended by the Task Force will be implemented by all municipalities, municipal authorities, utilities, fire departments and other responsible agencies in the affected area.

(2) Water and sewage system operators and public works departments should examine and adjust all maintenance schedules necessary to comply with the non-essential use regulations.

d. Public Water Supply System Use

(1) Public water supply systems will be responsible for monitoring compliance with the nonessential use regulations recommended by the Task Force applicable to consumers in their service area.

(2) Public water supply systems should accelerate on a priority basis the

implementation of all available conservation measures, including improving and accelerating leak detection surveys and repair programs, installing and calibrating meters, and other water saving measures that may be appropriate.

(3) The Department may publish and distribute to public water supply systems water conservation information and kits for distribution to consumers, in order to encourage and assist in compliance with water conservation restrictions.

(4) Public water supply systems will additionally implement the provisions of Local Water Shortage Contingency Plans and Local Water Rationing Plans, as necessary, to respond to water shortages and to balance demands with available supplies.

e. Electrical Generating Facilities

(1) The Department and the Utility Regulatory Commission will jointly consult with all major electric utilities in the region to ascertain the current status and projection of electric use demand, associated water requirements, and potential for energy and water conservation during the water shortage emergency. Consultations will consider the potential for: (a) shifting a portion of electric energy demand to generation from plants outside the area affected by the emergency (including increased wheeling of energy); (b) increasing energy production from plants with lower consumptive water use rates per unit of energy; and (c) adjustment of plant production and maintenance schedules within the system to reduce water use in the affected area.

(2) The Department and the Utility Regulatory Commission will jointly, in conjunction with Indiana electric utilities, initiate and maintain a concerted program to encourage conservation and reduction of electric use during the water shortage emergency.

f. Institutional Use

(1) The operators of all institutions will be responsible for complying with the non-essential use regulations.

(2) Other water use should be voluntarily reduced by implementing water conservation techniques. Accelerated efforts should be taken by residential and other large institutions to install water-saving plumbing devices.

g. Irrigation Use

(1) Current agricultural irrigation utilizing surface water sources should be voluntarily reduced by 10 to 15%, and when possible, conducted during non-peak evaporation and evapotranspiration hours, preferably after 5:00 p.m. and prior to 9:00 a.m. Irrigation should be avoided under conditions of high wind.

(2) Small scale agricultural irrigation utilizing surface water sources or water from a public water supply system should be voluntarily reduced. Irrigation utilizing water from a public water supply system should be limited to non-peak water usage hours.

(3) Landscape irrigation of new and existing installations utilizing surface water sources or water from a public water utility should be voluntarily reduced. Irrigation utilizing water from a public water system should be limited to non-peak water usage hours, using a handheld hose equipped with an automatic shut-off nozzle or a hand-held container for smaller areas.

(4) Inside and outside irrigation of nurseries utilizing surface water sources or water from a public water system should be voluntarily reduced. Irrigation utilizing water from a public water system should be limited to non-peak water usage hours.

(5) Irrigation of golf course fairways, roughs, and non-play areas utilizing surface water sources or water from a public water utility should be voluntarily eliminated. Irrigation of greens and tees utilizing water from a public water system should be limited to non-peak water usage hours.

(6) Irrigation of existing and new recreation areas utilizing surface water sources or water from a public water supply system shall be voluntarily reduced. Irrigation utilizing water from a public water system should be limited to non-peak water usage hours.

(7) Irrigation of gardens, trees, shrubs and other plants, except by a hand-held hose equipped with an automatic shut-off nozzle or container utilizing water from a public water supply system should be voluntarily limited to non-peak water usage hours.

(8) Treated wastewater irrigation should be encouraged, upon approval of IDEM.

(9) Freshwater used for irrigation should be applied at a minimum rate when possible.

h. Livestock and Poultry Water

Use shall be voluntarily reduced to absolute minimum levels necessary to maintain normal health, growth, production and reproduction of livestock and poultry.

i. Miscellaneous Uses

All aesthetic, recreation, outdoor irrigation, cleaning and other miscellaneous uses of water should be reduced or eliminated as dictated by the Task Force.

VII. Use of Ground Water and Water in Lakes, Reservoirs and Streams

The Department of Natural Resources was asked by the Legislature to consider provisions authorizing increased ground-water withdrawals, the use of a part of minimum ~~stream flows~~ streamflow and the use of water stored in lakes and reservoirs when a water shortage threatens the environment or the health, safety, welfare or economic well-being of the citizens. The following are recommendations concerning the availability of each of these water supplies that could be made available during a water shortage.

A. Ground Water

Significant amounts of ground water are available in various parts of the state which can be utilized to meet the short term needs that might be created by the water demands accompanying water shortage conditions. While long term production from new wells would need to be evaluated, the installation of wells to meet the temporary needs of water users during the duration of a drought would be possible in many cases without long term impacts to the resource. However, in the case of public water supply wells, the permitting process of the Indiana Department of Environmental Management may have to be expedited to allow for quick installation of wells. While the necessary data to conduct a detailed analysis of the long term impacts of these well constructions could not be assembled in a timely fashion, information available through the Department's Division of Water Ground Water Section would be sufficient to provide an evaluation of the short term impacts of emergency ground-water development.

B. Minimum ~~Stream Flows~~ Streamflow

The Water Shortage Task Force is not comfortable establishing a new minimum stream flow standard that could be considered for other regulatory purposes. Recognizing that it is desirable to protect the 7Q10 flow where possible to ensure that water quality is maintained, it would be desirable to initiate reduction to water withdrawals at some point prior to the 7Q10. Therefore, the following recommendations are made:

1. Upon declaration of a Warning Phase as described in Section VI, the Department shall advise, by telephone or letter, all owners of water withdrawal facilities in the affected areas, and registered as required by Indiana Code 14-25-7-15, of the declaration of the Warning Phase and encourage these users to voluntarily reduce their water usage by a higher percentage than the 10 to 15% reduction targeted by the conservation measures suggested for the Warning Phase.

2. Upon declaration of a Warning Phase, the Indiana Department of Natural Resources shall assess the instream flow demands on those streams within the affected area. As a part of this review the Department may consider data or studies which might be available from other sources including the users on the affected streams, consultants and other governmental agencies. The Department shall advise the Task Force of the instream flow needs identified on selected

streams, the flow needed to maintain each need and an assessment of the long and short term impacts of allowing withdrawal of portions of those flows needed to meet the identified instream demands. A summary of these findings will be provided to the owners of all registered water withdrawal facilities.

C. Lakes

The State's natural lakes should only be looked to as a water supply source in time of water shortage if there is imminent danger to the public health safety and welfare.

D. Reservoirs Containing State Owned Water Supply Storage

Since the state has available water supply storage in these reservoirs, statutory changes should be made to allow the Department to enter into short term contracts within a short time frame to allow use of the uncommitted water supply storage in these reservoirs. Priority use should be dictated by the specific uses authorized by the contracts between the State of Indiana and the United States of America on each reservoir.

E. Flood Control Reservoirs

Discussion should be initiated with the U.S. Army Corps of Engineers to determine if waters from the reservoirs may be made available for use during a water shortage and suitable agreements developed to establish a mechanism to authorize use of such waters that may be available.

VIII. Water Use Priorities

A. General

During times of water shortage, the need to reduce demand on the resource can and will exist. Decisions regarding the uses which are deemed to have the highest priority will not be easy and may not be clear cut. Indiana Code 14-25-1-3 provides that: "the owner of land contiguous to or encompassing a public water course shall at all times have the right to the use of water therefrom in the quantity necessary to satisfy his needs for domestic purposes, which shall include, but not be limited to, water for household drinking purposes and drinking water for livestock, poultry and domestic animals. The use of water for domestic purposes shall have priority and be superior to any and all water uses."

The priorities of other uses must therefore be determined on some reasonable standard. Guidance in these decisions may be found in policy statements made in both Indiana Code 14-25-1-1 and 14-25-3-3 which state: "(a) that the general welfare of the people of the State of Indiana requires that the surface water resources of the state be put to beneficial uses to the fullest extent and that the use of water for non beneficial uses be prevented..."; and (b) "It is a public policy of this state in the interest of the economy, health, welfare of the state and the citizens of Indiana, to conserve and protect the ground water resources of the state...” In addition, Rule 312 IAC 6.3-4-1 establishes the following water allocation priorities for withdrawals from State financed reservoirs under the provisions of IC 14-25-2:

A) First Priority is for the use of water for domestic purposes as described in IC 14-25-1-3.

B) Second priority is for the use of health and safety.

C) Third priority is for power production that meets the contingency planning provisions of the drought alerts described in 312 IAC 6.3-5-2.

D) Fourth priority is for industry and agriculture (not described in A, B, or C) that meets the contingency planning provisions of the drought alerts described in 312 IAC 6.3-5-2.

E) Fifth priority is for a purposed described in clause (C) or (D) that does not meet the contingency planning provisions of the drought alerts described in 312 IAC 6.3-5-2.

F) Sixth priority is for any other purpose.

In establishing priorities, emphasis must be given to high capacity water uses (withdrawals by Significant Water Withdrawal Facilities) since these users have the largest impact on the resource. The following seven (7) Categories have been established for Significant Water Withdrawal Facilities in Indiana ~~these users and include the following 7 uses~~:

(1) Domestic Supply
(2) Public Supply
(3) Energy Production
(4) Irrigation
(5) Industrial
(6) Rural
(7) Miscellaneous

It should be noted that these are all water withdrawal categories ~~uses~~ and do not include instream uses. Certain instream uses will have little or no priority in the event of serious drought but may bring the loudest public outcry. Included in these uses would be swimming, recreational boating, and aesthetic appearances. Other instream uses such as minimum ~~stream flows~~ streamflow to prevent water quality degradation or wetlands preservation must be recognized and addressed as a priority use.
In managing a reduced resource in times of water shortage it is important to recognize that portions of the water utilized in each of the above segments is necessary while others are not. For example:

1. Drinking water for customers, health care facilities, and fire fighting is high priority while water for lawn watering and car washing is not.

2. Cooling water for electrical generating stations is necessary for the production of electricity; however, in times of water shortage the continuous running of air conditioners raises demand but may not be necessary for all users.

3. Irrigation uses involve both crop production and golf course watering. Crop production would seem to be more important than keeping green grass on a golf course.

~~A simple ranking of the eight above mentioned uses (instream uses being number 8) would be a simplistic approach to managing the water resource. In addition to the problems within each of these categories,~~ It should be noted that some water withdrawal categories or uses will not exist within each of the 12 Water Shortage Identification Regions. In addition, within each withdrawal category ~~use~~, some users will be more efficient or more effective in conserving the water resource~~s~~.

B. Conclusion

The "water allocation priorities" established in Rule 312 IAC 6.3-4-1 shall be implemented during a water shortage. In addition, the following recommendations are made relative to establishing other water use priorities in times of water shortage:

1. Consideration should be given to both instream and withdrawal uses, and whether the source is from surface water or ground water.

2. All management decisions should attempt to preserve minimum ~~stream flows~~ streamflow in accordance with the discussion in the section which follows.

~~3. Domestic water supply shall have the highest priority.~~

~~4. All uses essential for protecting the public health, safety, and welfare shall have priority.~~

~~5~~3. Priorities should be assessed in each Water Shortage Identification Region based upon existing uses. Regional advisory boards consisting of at least a representative of each water use may be created once a Water Shortage Warning is in effect.

~~6~~4. Non-Essential uses should be given lowest priority.

~~7~~5. Water use restrictions should be evaluated in light of the use. For example, a 10% mandatory reduction on all uses may result in a loss of a higher percentage of generating capacity at a power plant.

~~8~~6. Water users promoting or demonstrating efficiency and/or conservation ~~in use~~, or that comply with contingency planning provisions, should be given higher priority than those users not demonstrating such capability.

~~9~~7. Existing users shall be given priority over new users within each of the six water allocation priorities specified in Rule 312 IAC 6.3.~~unless such use is necessary for maintaining the public health, safety and welfare~~.

~~10~~8. Distinctions should be made between consumptive and non-consumptive uses.

~~11~~9. In accordance with IC 14-25-4-12, the ground-water resource of an area shall be protected against high capacity withdrawals that exceed the recharge capability of the resource.

IX. Overview of Water Shortage Plan Development

A. General

During the early summer of 1988, cumulative rainfall amounts were significantly below normal levels and Indiana, as well as many other Midwestern States, was clearly in the midst of a severe drought. Climatological data indicated that by the end of June the plight of many drought stricken areas would reach the crisis level. As a result on June 22, 1988, Governor Robert D. Orr created the Indiana Drought Advisory Committee to coordinate at the state level all of the issues related to drought. Membership of the Committee included representatives of a large number of agencies and the findings of the Committee were included in the Indiana Drought Advisory Committee Report, September, 1988. Presented in the report is an overview of drought associated problems throughout the state coupled with identified solutions to those problems.

The introduction to the Committee's report concludes by stating: "This report is intended to serve as a preparatory document in the event that Indiana experiences a rainfall shortage in the future similar in severity to the 1988 drought and it is hoped that the information contained herein will help expedite the state's reaction in the future should a drought occur". While the 1988 Drought Committee addressed a broad spectrum of drought related issues, their report contains information concerning significant problems related to reduction of the water resource as a result of the drought. The experiences of the 1988 Drought suggested to the Indiana Department of Natural Resources that a drought of similar or greater severity would lead to significant conflicts between the users of the state's water resource, and no clear cut guidelines exist at the state level to address and/ or respond to these conflicts. In addition, there are currently no guidelines available for existing and potential users of the state's water resources to identify what actions would be taken by the State in times of water shortage. As a result, the Department suggested to the Water Resources Study Committee that there was a need for the State of Indiana to develop a plan which would outline the actions which would or could be taken at the State level in times of water shortage.

The plan was developed with the advice and assistance of the Advisory Council for the Bureau of Water and Resources Regulation augmented by 8 additional members, appointed by Governor Evan Bayh, with expertise or responsibility in matters relevant to water shortage.

As required by statute, five public meetings were held to receive public comment on the draft plan and on problems the plan is to address. The dates and locations of these meetings are as follows:

Location	Date	Time
(1) Vincennes	March 14, 1994	7:00 p.m., E.S.T.
(2) Columbus	March 15, 1994	6:00 p.m., E.S.T.
(3) Indianapolis	March 15, 1994	9:00 a.m., E.S.T.
(4) Elkhart	March 16, 1994	9:00 a.m., E.S.T.
(5) Valparaiso	March 16, 1994	7:00 p.m., C.S.T.

The comments received were reviewed and considered by the Advisory Council and appropriate amendments to the plan were made based on these comments. This final report which is being submitted to the Water Resources Study Committee includes the following:

1. A plan to address state water management actions.
2. Documents which might provide assistance to communities, individuals and agriculture in responding to the effects of a water shortage.
3. Recommendations for possible legislation to implement the plan.

In preparing this plan, the members looked to the 1980 Governors Water Resource Commission publication entitled “The Indiana Resource: Recommendations for the Future” which describes two categories of water uses: Withdrawal and instream. Instream uses are defined as those which are made of surface water in place. They include fishing, boating, swimming, urban and agricultural drainage, the disposal of liquid wastes, navigation, hydroelectric power generation, the passage of flood flows, and general aesthetic enjoyment. In addition, surface water is the natural habitat of a variety of birds and animals. Of these varied uses aquatic organisms, fishing, swimming and aesthetic enjoyment are directly and immediately related to water quality. Commercial navigation, recreational boating and hydroelectric power are dependent upon adequate and dependable flows, depths and surface areas. The waste assimilative capacity of streams is a direct function of the rate of ~~stream flow~~ streamflow. Finally, it is important to note that many instream use demands reach their peak during natural low flow periods for streams.

Withdrawal uses are defined as those uses which involve the physical removal of water from its ground or surface source. Withdrawal uses include both consumptive and non-consumptive uses. Consumptive uses are those that, because of evaporation, transfer out of the basin of origin, incorporation into manufactured products or other processes, preclude the return of some or all of the withdrawn water to its source. Non-consumptive uses as the term implies are those in which the withdrawn water is returned to the supply system essentially undiminished in volume. In Indiana, withdrawal uses have been divided into the following categories: Public Supply, Irrigation, Energy Production, Industrial, Rural and Miscellaneous. Similar to instream uses, many withdrawal and consumptive uses peak during natural low flow.

In attempting to manage a reduced resource during periods of water shortage, it is important that both categories be considered. Protection of instream flows to prevent water quality degradation and damage to aquatic habitat such as wetlands and fisheries should not be sacrificed in the short term without consideration of the long term impacts of such acts on the environment. However it should be recognized that in establishing priorities of water use in water shortage conditions, certain withdrawal and instream uses will receive little or no consideration.

In order to balance and manage these uses in times of water shortage it is important to note the state policy set forth in IC 13-12-4-3.

"(a) the general assembly...declares that it is the continuing policy of the state of Indiana in cooperation with the federal and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Indiana citizens.
(b) In order to carry out the policy set forth in this chapter, it is the continuing responsibility of the state of Indiana to use all practicable means, consistent with other essential considerations of state policy, to improve and coordinate state plans, functions, programs and resources to the end that the state may:

(1) Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
(2) Assure for all citizens of Indiana safe, healthful, productive, and aesthetically and culturally pleasing surroundings;
(3) Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;
(4) Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice;
(5) Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and
(6) Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources."

The impacts of drought or water shortage may extend beyond the water resource and ultimately may involve differing levels of government. It is not the intent of this plan, or the legislative directive to develop a plan which would address government's response to all the consequences of a drought or a water shortage. This plan deals only with issues related to a diminishing water resource and is intended to improve the State of Indiana's ability to recognize the onset of a water shortage and to respond so as to minimize the impacts of such an event on the State's water users and its environment.

B. Determination of Water Shortage Definition

Water shortages are most commonly thought of in terms of drought. Drought is difficult to define and many different definitions have emerged. Hydrologists think of a drought in terms of the effects of precipitation deficits on ground-water levels, streamflow, and reservoirs. To a meteorologist, a prolonged period of moisture deficit, be it 1 month or 1 year, denotes a drought of varying severity. A water manager defines a drought relative to water availability and quality. Reduction in available supply for whatever reason or degradation of water quality can result in a water shortage. Either of the above could occur independent of climatic factors. If a water shortage occurs during a critical phase of the growing cycle, even a very short period with a moisture deficit can become a costly drought to a farmer. Residential consumers often are unaware of water shortage conditions until they are affected directly by water restrictions and shortages.

Water shortages caused by reasons other than drought would probably impact smaller areas and may not be recognized until a crisis situation exists. It is hoped that this document can be useful in managing the water resource no matter what the cause. However for purposes of discussing the onset of a water shortage it is useful to look at the definition of drought and the criteria for identifying the onset of drought.

A drought can be defined in general terms as "... a condition of moisture deficit, sufficient to have an adverse effect on vegetation, animals, and man over a sizable area". Any one definition is not adequate for all situations because droughts are measured using different criteria, including precipitation and temperature statistics, ground-water levels and low-flow characteristics, soil moisture values, and economic factors (for example, crop yields and livestock production).

Six types of drought are recognized by the World Meteorological Organization. They are:

(1) Meteorologic drought — defined only in terms of precipitation deficits in absolute amounts for specific durations.

(2) Climatologic drought — defined in terms of precipitation deficits, not in specific amounts but as a ratio of actual precipitation to mean or normal values.

(3) Atmospheric drought — definitions involve not only precipitation but possible temperature, humidity, or wind speed.

(4) Agricultural drought — definitions involve principally soil-moisture content and plant physiology, perhaps for a specific crop.

(5) Hydrologic drought — defined in terms of reduced streamflow, reductions in lake or reservoir storage, and declining ground-water levels.

(6) Water-management drought — characterizes water deficits resulting from water-management practices or facilities.

The drought types can occur separately, overlap, or be combined in different ways. For example, a small amount of precipitation (a meteorologic drought), when extended over a long period, becomes a climatologic drought. As ground-water, streamflow, and reservoir levels decline, a hydrologic drought occurs, resulting in problems of water distribution and use, which then becomes a water-management drought.

1. Conclusion

Definitions numbered 5 and 6 appear to most closely describe "water shortage" as envisioned by the legislature.

C. Determination of Water Shortage Identification Regions

It is recommended that the identification of water shortage conditions in the State of Indiana be made using the 9 climate divisions determined by the National Weather Service as shown in Figure 1. Monthly precipitation data are prepared for each climate division by the National Drought Mitigation Center (NDMC), the National Climatic Data Center (NCDC), the Western Regional Climate Center (WRCC) and the Indiana Department of Natural Resources (IDNR). Utilizing these 9 climate divisions for the identification of water shortage is appropriate because the lack of precipitation is a principal factor involved in periods of drought, and precipitation deficits typically exist prior to the observation of more significant and obvious effects on plants, animals and people. The determination of these Water Shortage Identification Regions does not diminish the need for the State of Indiana to develop the regional water planning areas necessary to address management and distribution of the resource during times of shortage.

D. Determination of Criteria to Identify Onset of Water Shortage

The Water Shortage Task Force reviewed criteria for identifying the onset and various stages of severity of a water shortage. Factors on which to base such criteria include: available drought indices streamflow, ground-water levels, available reservoir storage, precipitation, and season (Table 2, Appendix IV). It should be noted that since drought is a natural climatic event, it is easier to identify its onset than water shortages which may result from water management practices or system failures. The latter will most likely be unanticipated and in many cases at a more advanced stage of severity once it is brought to the attention of appropriate authorities.

The three indicators selected as the most appropriate for identifying the onset and stage of a water shortage follows:

Table 2. Review of Available Drought Indices

Indices	Method	Application
Percent of Normal	Percent of Normal is a simple method to detect drought. It is calculated by dividing actual precipitation by normal precipitation –typically a 30-year mean and multiplying it by 100%	**Pros:** Percent of Normal is effective in single region or season. **Cons:** Percent of Normal cannot determine the frequency of the departures from normal or compare with different locations. Also, it cannot identify specific

	for each location. Data are not normalized.	impact of drought or the inhibition factor for drought risk mitigation plans.
Standardized Precipitation Index (SPI)	SPI is a simple index which is calculated from the long term record of precipitation in each location (at least 30 years). The data will be fitted to normal distribution and be normalized to a flexible multiple time scale such as 3-,6-,12-,24-, 48-month and etc .	SPI is used to identify the meteorological drought or deficit of precipitation. **Pros:** SPI can provide early warning of drought and its severity because it can specify for each location and is well-suited for risk management. **Cons:** The data can be changed from the long term precipitation record. The long time scale up to 24 months is not reliable.
Palmer Drought Severity Index (PDSI)	PDSI complexity is calculated from precipitation, temperature and soil moisture data. Soil moisture data has been calibrated to the homogeneous climate zone. PDSI has an inherent time scale of 9 months. PDSI treats all forms of precipitation as rain.	**Pros:** PDSI has been widely used to trigger agricultural drought. PDSI can be used to identify the abnormality of drought in a region and show the historical aspects of current conditions. **Cons:** The PDSI may lag in the detection of drought over several months because the data depend on soil moisture and its properties which have been simplified to one value in each climate division. The PDSI will not present accurate results in winter and spring due to the effects of frozen ground and snow. PDSI also tends to underestimate runoff conditions.
Palmer Hydrological Drought Index (PDHI)	PHDI has been derived from the PDSI index to quantify the long term impact from hydrological drought.	**Pros:** The PHDI has been officially used by the National Climatic Data Center to determine the precipitation needed for drought termination and amelioration which has a PHDI equal to -0.5 and -2.0 consecutively. It has been used in Indiana for drought monitoring. **Cons:** The PHDI is developed from precipitation, outflow, and storage. PHDI may change more slowly than PDSI and it has sluggish response for drought.
Crop Moisture Index (CMI)	CMI is a derivative of PDSI which was developed from moisture accounting procedures as the function of the evapotranspiration anomaly and the moisture excesses in the soil. It also can be present as the monthly moisture anomaly or Z index (ZNDX) as a product from PDSI calculation. CMI looks at the top 5 feet of the soil layer.	**Pros:** CMI is used to monitor crop condition. It is effective for the detection of short term agricultural drought while the Z index determines drought on a monthly scale. It can detect drought sooner than PDSI and PHDI. **Cons:** CMI is limited to use only in the growing season; it can not determine the long term period of drought.
Surface Water Supply Index(SWSI)	SWSI is used for frequency analysis to normalize long-term data such as precipitation, snow pack, streamflow, and reservoir	**Pros:** The SWSI is very useful for indicating snow pack conditions in mountain areas to measure the water supplied for a community.

	level.	**Cons:** The index of different basins can not be compared with each other and has been computed seasonally. States such as Colorado, Oregon, Montana, Idaho, and Utah have used SWSI.
Reclamation Drought Index (RDI)	The RDI index is similar to the SWSI index. It combines the functions of supply, demand and duration. RDI also combines temperature features and duration in the index.	**Pros:** The RDI is used as the trigger to evaluate drought reclamation plans and to release drought emergency funds. **Cons:** The disadvantage of RDI is the same as the SWSI index. The State of Oklahoma has used RDI.
Deciles	Deciles have been developed to use instead of percent of normal. Deciles are calculated from the number of occurrences distributed from 1 to 10. The lowest value indicates conditions drier than normal and the higher value indicates conditions wetter than normal.	**Pros:** The deciles index has been used in Australia; it provides accurate precipitation data for drought response. **Cons:** Its use requires a long climatology record to accurately calculate the deciles index.
Experimental Objective Blends of Drought Indicators	Drought Blend Indicators are divided into short-term and long-term blends. The short term blend includes PDSI, Z, SPI 1, 3-month, and soil moisture. The long-term blend includes PHDI, SPI 06 12 24 and 60-month, and soil moisture. The drought blend method has been used for US drought monitoring: http://www.drought.unl.edu/dm/monitor.html	In the short-term blend method, the indicators are weighted to the precipitation and soil moisture which are used to identify the impacts of no irrigated agriculture, wildfire dangers, top soil moisture, and pasture conditions. The long-blend index indicates the impacts of hydrological drought such as reservoir and well levels and irrigated agriculture. The drought indicator used in Drought Monitor provides the most widely used map for drought conditions across the United States (and is suitable for Indiana).

Source: *Drought Indices, Michael J. Hayes, National Drought Mitigation Center (http://www.drought.unl.edu/whatis/indices.htm). With modifications by Dev Niyogi and Umarporn Charusambot, Indiana State Climate Office, Purdue University (http://iclimate.org)*

1. Standardized Precipitation Index (SPI)

The Standardized Precipitation Index was developed in 1993 and is a simple index that is calculated for any location based on the long-term precipitation record (typically 30 years or greater). This long-term record is fitted to a probability distribution, which is then transformed into a normal distribution so that the mean SPI for the location and desired period is zero. Positive SPI values indicate greater than median precipitation (i.e. wet conditions), and negative values indicate less than median precipitation (i.e. dry conditions). The SPI was designed to quantify the precipitation deficit for multiple time scales. These time scales reflect the impact of drought on the availability of the different water resources. Soil moisture conditions respond to precipitation anomalies on a relatively short scale. Groundwater, streamflow, and reservoir storage reflect the longer-term precipitation anomalies. For these reasons, the SPI is calculated for 1–, 3–, 6–, 12–, 24–, and 48–month time scales. Short-term SPI values can be used to detect agricultural drought and long-term SPI values can be used for water supply management, as is also shown on the U.S. Drought Monitor.

Negative SPI values provide warning of a developing drought. During drought, the magnitude of negative SPI values indicates drought severity. Values of the SPI normally range from +2 to -2. An index of +2.0 or greater indicates extremely wet conditions; +1.99 to +1.50, very wet conditions; +1.49 to 1.00, moderately wet; +0.99 to -0.99, near normal to abnormally dry; -1.0 to -1.49, moderately dry; -1.50 to -1.99, severely dry; and -2 and less, extremely dry.

Indiana is divided into 9 climatologic divisions by the National Weather Service as shown in Figure 1. Standardized Precipitation Index values for Indiana are prepared for each division on a monthly basis by the NDMC, the NCDC, WRCC, and IDNR. The reported SPI values by each individual organization can vary slightly because of two reasons; statistical calculation methods and differences in provisional precipitation. The SPI is computed with preliminary data that have undergone little quality control at the time of use and the list of stations that goes into that product can change each month. If for some reason the data for a station does not come in, or has too many missing days, then it is not used. So, in theory, each month a different number of stations could be used each and every month. In computing a divisional average, the precipitation stations that are used are weighted using various distance-weighting functions to come up with a value for the division. Divisional precipitation used to calculate the SPI is obtained monthly from the Midwest Regional Climate Center (MRCC) by the IDNR. Although there are currently 390 cooperative Indiana precipitation reporting stations, only about 70 of those stations report in real time. In addition, the data are screened by the MRCC to exclude reporting Indiana cooperative observing stations that had greater than 10% of their observations missing. For example, the 70 stations used for the May 2008 divisional precipitation calculation are shown in Figure 2.

The SPI can be computed at a more local scale where precipitation data are available but is currently available only as an experimental product by the National Drought Mitigation Center. Suggested drought stage indices for Indiana are as follows:

Stage	Standardized Precipitation Index
Normal	+0.99 to -0.99
Drought Watch	-1.00 to -1.49
Drought Warning	-1.50 to -1.99
Drought Emergency	-2.00 or less

2. U.S. Drought Monitor

The U.S. Drought Monitor began in 1999 and is a synthesis of multiple climate monitoring tools as well as the informed judgments of its authors and federal, state, and academic reviewers across the country. The U.S. Drought Monitor Map is produced weekly and summarizes information onto a single, easy-to-read colored map. The main partners of the U.S. Drought Monitor are listed below.

Main federal partners:

- Joint Agricultural Weather Facility (U.S. Department of Agriculture and Department of Commerce/National Oceanic and Atmospheric Administration)
- Climate Prediction Center (U.S. Department of Commerce/NOAA/National Weather Service)
- National Climatic Data Center (DOC/NOAA)

Figure 2. The 70 provisional real-time MRCC precipitation stations for May 2008.

Partners of the U.S. Drought Monitor (continued):

Academic partner:

- National Drought Mitigation Center (University of Nebraska-Lincoln)

Other participants:

- U.S. Geological Survey (U.S. Department of Interior)
- National Water and Climate Center (USDA/Natural Resource Conservation Service)
- Climate Diagnostics Center (DOC/NOAA)
- Regional Climate Centers
- National Weather Service Hydrology (DOC/NOAA)
- State Climatologists
- additional local, state, and federal experts

Interpreting the Map

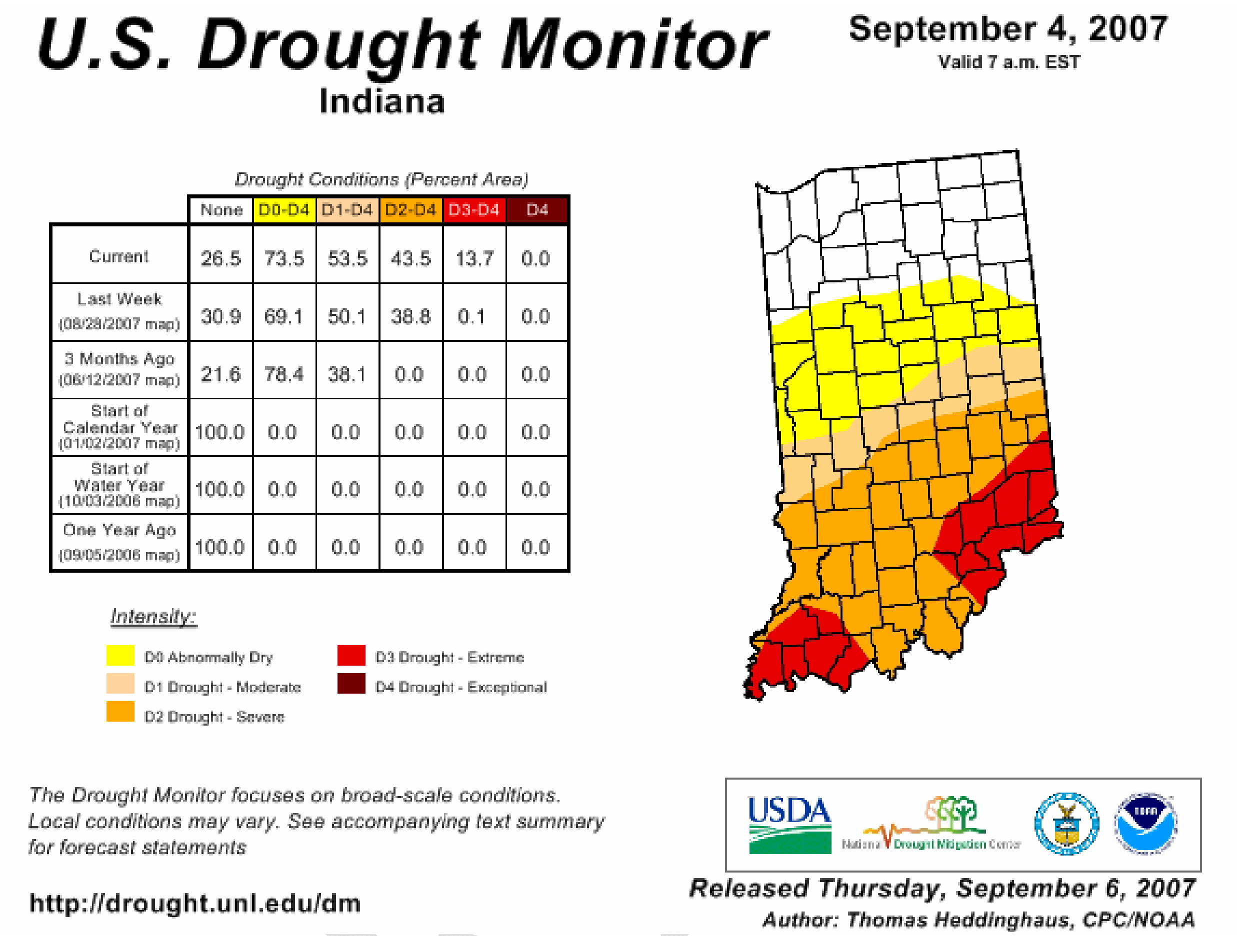
The Drought Monitor Map identifies general drought areas, labeling droughts by intensity, with D1 being the least intense and D4 being the most intense. The Map Key categories are listed in Table 3. An example of the Drought Monitor Map for Indiana is shown in Figure 3.

The Drought Monitor key indicators are associated with occurrence levels:
D0 corresponds to a 1 in 3 year occurrence
D1 corresponds to a 1 in 5 year occurrence
D2 corresponds to a 1 in 10 year occurrence
D3 corresponds to a 1 in 20 year occurrence
D4 corresponds to a 1 in 50 year occurrence

Since "drought" means a moisture deficit bad enough to have social, environmental, or economic effects, the Drought Monitor generally includes a description of what the primary physical effects are:
A = agricultural (crops, pastures, and grasslands)
H = water supplies (rivers, groundwater, and reservoirs)

Table 3. U.S. Drought Monitor Map Key Categories

D0	Abnormally Dry	Going into drought; Coming out of drought
D1	First-Stage Drought	Some damage to crops, pastures; streams, reservoirs, or wells low; some water shortages developing or imminent
D2	Severe Drought	Crop or pasture losses likely; water shortages common
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	26.5	73.5	53.5	43.5	13.7	0.0
Last Week (08/28/2007 map)	30.9	69.1	50.1	38.8	0.1	0.0
3 Months Ago (06/12/2007 map)	21.6	78.4	38.1	0.0	0.0	0.0
Start of Calendar Year (01/02/2007 map)	100.0	0.0	0.0	0.0	0.0	0.0
Start of Water Year (10/03/2006 map)	100.0	0.0	0.0	0.0	0.0	0.0
One Year Ago (09/05/2006 map)	100.0	0.0	0.0	0.0	0.0	0.0

Figure 3. An example of an Indiana U.S. Drought Monitor Map.

How the Map is Made

Climate divisions were originally identified as the highest level of detail at the state level on the U.S. Drought Monitor Map. An enhanced version of the U.S. Drought Monitor went live in September 2006 with state-level breakdowns that include county lines. The U.S. Department of Agriculture officials have tied emergency assistance to counties identified as being in D3, extreme drought, or D4, exceptional drought, during the growing season. The U.S. Drought Monitor can be tweaked because producers rely on supplemental information from Regional Climate Centers, State Climatologists, local county extension agents, and local National Weather Service offices. Drought intensity categories are based on six key indicators and numerous supplementary indicators. The drought severity classification table (Table 4) shows the ranges for each indicator for each dryness level. Because the ranges of the various indicators often do not coincide, the final drought category tends to be based on what the majority of the indicators show. The analysts producing the map also weight the indices according to how well they perform in various parts of the country and at different times of the year.

Table 4. U.S. Drought Monitor Drought Severity Classification Table.

Drought Severity Classification						
		Ranges				
Category	Description	Palmer Drought Index	CPC Soil Moisture Model (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	*Objective Short and Long-term Drought Indicator Blends (Percentiles)
D0	Abnormally Dry	-1.0 to -1.9	21-30	21-30	-0.5 to -0.7	21-30
D1	Moderate Drought	-2.0 to -2.9	11-20	11-20	-0.8 to -1.2	11-20
D2	Severe Drought	-3.0 to -3.9	6-10	6-10	-1.3 to -1.5	6-10
D3	Extreme Drought	-4.0 to -4.9	3-5	3-5	-1.6 to -1.9	3-5
D4	Exceptional Drought	-5.0 or less	0-2	0-2	-2.0 or less	0-2

*Short-term drought indicator blends focus on 1-3 month precipitation. Long-term blends focus on 6-60 months. Additional indices used, mainly during the growing season, include the USDA/NASS Topsoil Moisture, Keetch-Byram Drought Index (KBDI), and NOAA/NESDIS satellite Vegetation Health Indices. Indices used primarily during the snow season and in the West include snow water content, river basin precipitation, and the Surface Water Supply Index (SWSI). Other indicators include groundwater levels, reservoir storage, and pasture/range conditions.

<u>Indiana Water Shortage Stages and the U.S. Drought Monitor Map</u>

For the purposes of Water Shortage Stages for Indiana, it is recommended that the highest level of drought intensity that encroaches into a county use that level for the county as a whole. The climate divisions and county boundaries are outlined in Figure 4 for the U.S. Drought Monitor Map report date of September 4, 2007.

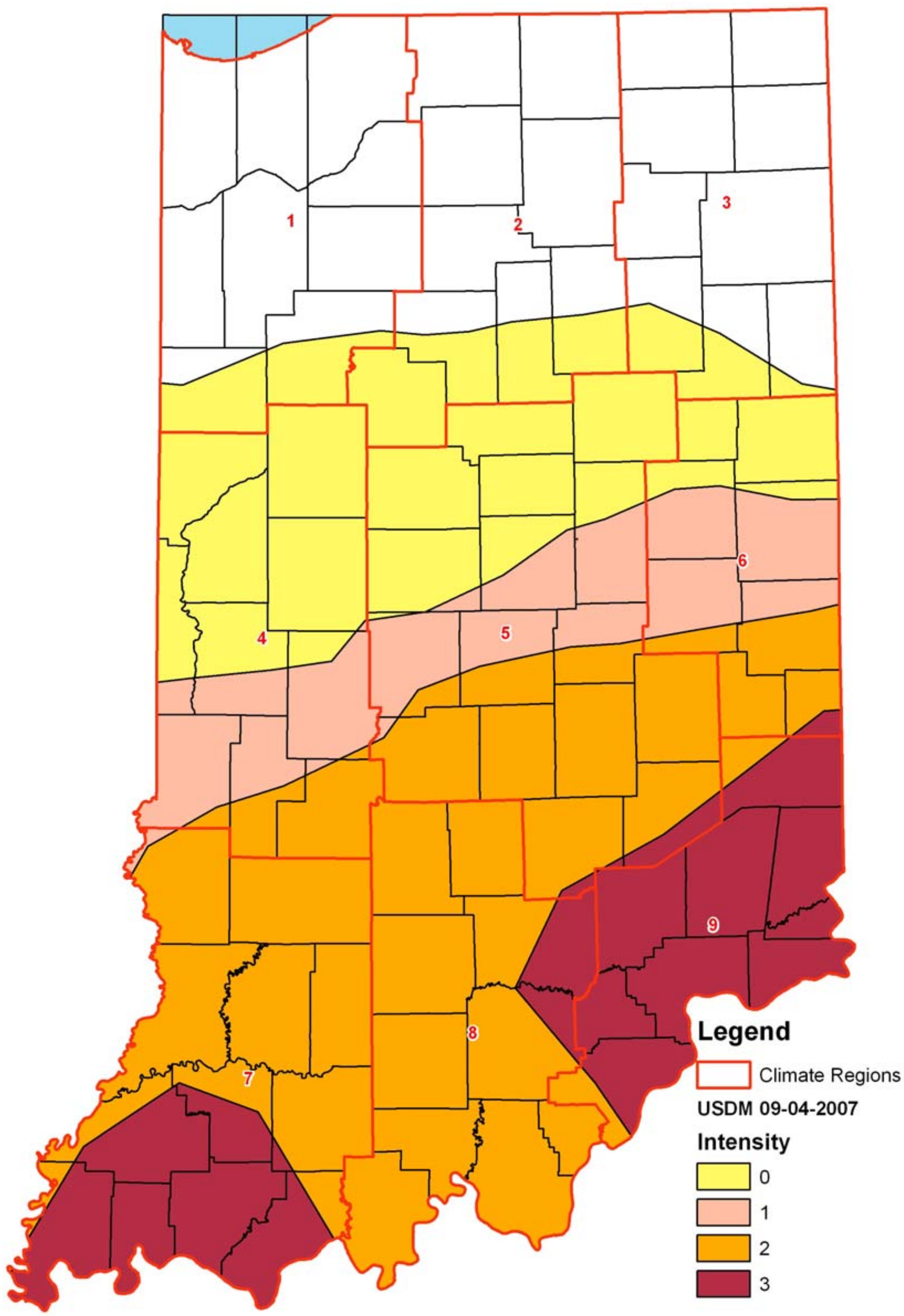


Figure 4. The U.S. Drought Monitor Map with climate regions for September 4, 2007.

3. Streamflow

It is recommended that streamflow as percentile of normal (average) is utilized as one of the indicators for Indiana's Water Shortage Stages as outlined:

Streamflow as Percentile of Normal (Average Streamflow)

Normal	25 or greater
Watch	10 to 24
Warning	6 to 9
Emergency	5 or less

Streamflow at the 25th percentile means that streamflow is only 25% of the historical average streamflow for that particular month. Lower percentiles correspond to increasingly lower streamflow and drought conditions.

The U.S. Geological Survey, in cooperation with the Department of Natural Resources, maintains a network of approximately 165 gaging stations in Indiana. Twenty-seven of these stations were selected to monitor drought conditions in 1988. Those 27 stations, along with the Maumee River at New Haven, are recommended for purposes of this plan. The 28 streamflow gaging sites recommended for use in Indiana's Water Shortage Plan are:

- Whitewater River near Alpine
- Little River near Huntington
- Mississinewa River at Marion
- Wabash River at Peru
- Eel River at North Manchester
- Tippecanoe River near Ora
- Wildcat Creek near Lafayette
- Wabash River at Lafayette
- Sugar Creek at Crawfordsville
- Wabash River at Terre Haute
- Wabash River at Riverton
- White River near Nora
- Fall Creek near Fortville
- White River near Centerton
- Big Blue River at Shelbyville
- Sugar Creek near Edinburgh
- Flatrock River at St. Paul
- East Fork White River at Seymour
- Muscatatuck River near Deputy
- White River near Petersburg
- Wabash River at Mount Carmel, IL
- Elkhart River at Goshen
- East Fork White River at Shoals
- St. Marys River at Decatur
- Yellow River at Knox
- Kankakee River at Dunns Bridge
- Kankakee River at Shelby
- Maumee River at New Haven

Table 5 shows a list of the streams, their climate division, and the U.S. Geological Survey streamflow gaging site number. Figure 5 shows the location of the recommended streamflow gaging sites.

Table 5. Climate Divisions and Recommended Streamflow Gaging Sites for Indiana's Water Shortage Plan

Climate Division 1 – NW	**U.S. Geological Survey Site Number**
Tippecanoe River near Ora	03331500
Yellow River at Knox	05517000
Kankakee River at Dunns Bridge	05517500
Kankakee River at Shelby	05518000
Climate Division 2 – NC	
Elkhart River at Goshen	04100500
Eel River at North Manchester	03328000
Wabash River at Peru	03327500
Climate Division 3 – NE	
Little River near Huntington	03324000
St. Marys River at Decatur	04181500
Maumee River at New Haven	04183000
Climate Division 4 – WC	
Wabash River at Lafayette	03335500
Wildcat Creek near Lafayette	03335000
Sugar Creek at Crawfordsville	03339500
Wabash River at Terre Haute	03341500
Climate Division 5 – C	
Mississinewa River at Marion	03326500
Fall Creek near Fortville	03351500
White River near Nora	03351000
Big Blue River at Shelbyville	03361500
White River near Centerton	03354000
Flatrock River at St. Paul	03363500
Sugar Creek near Edinburgh	03362500
Climate Division 6 – EC	
Whitewater River near Alpine	03275000
Climate Division 7 – SW	
Wabash River at Riverton	03342000
East Fork White River at Shoals	03373500
White River at Petersburg	03374000
Wabash River at Mt. Carmel	03377500
Climate Division 8 – SC	
East Fork White River at Seymour	03365500
Climate Division 9 – SE	
Muscatatuck River near Deputy	03366500

Figure 5. Indiana Water Shortage Plan recommended streamflow gaging sites.

4. Conclusion

The 1-month Standardized Precipitation Index, the U.S. Drought Monitor, and below normal percentiles of regionalized monthly average streamflow have been selected as drought indicators for Indiana's Water Shortage Plan. The "Water Shortage Stages" for the purposes of this plan means the four stages that are designated based on the value of the indicators (Table 6). The stage is defined as Normal if no more than one indicator is outside of the normal range. ~~The U.S. Drought Monitor map will be used on an interim basis for the purpose of defining drought within the State of Indiana. The action plan will be triggered for a county when any part of a county is defined as having drought conditions.~~ It is recommended that Water Shortage Identification Regions coincide with the nine climate divisions established by the National Weather Service (Figure 1).

Table 6. Criteria to Identify Drought Conditions and Water Shortage Stages

Water Shortage Stages	1-Month Standardized Precipitation Index	U.S. Drought Monitor (Conditions)	Streamflow As Percentile Of Normal (Average Streamflow)
Normal (White and Yellow)	+0.99 to -0.99	None to D0	Greater than or equal to 25
Watch (Tan)	-1.00 to -1.49	D1	10 to 24
Warning (Orange)	-1.50 to -1.99	D2	6 to 9
Emergency (Red)	-2.00 or less	D3 to D4	5 or less

X. Identification of Additional Water Supplies Available During a Water Shortage

A. Increased Ground-Water Withdrawals

1. Introduction

Ground water represents an important source of water supply in Indiana; however, only about ~~five~~ six percent of the state's total water use during ~~1990~~ 2006 was reported to be from ground-water supplies. During periods of water shortage due to drought conditions, further development of the existing ground-water resource could represent an abundant and reliable source of water throughout much of the state in order to meet the emergency.

2. Current Supply and Demand

IC 14-25-7-11 calls for the continued assessment of the state's surface and ground-water resources. IC 14-25-7-15 requires that all "significant water withdrawal facilities" register with the Natural Resources Commission (NRC), and report annual water withdrawals. By the end of ~~1990~~ 2006 there were ~~3,119~~ 3,507 active registrations on file with the department, including ~~4,710~~ 5,997 wells and ~~1,398~~ 1,409 surface intakes.

During ~~1990~~ 2006, total water use was reported to be approximately ~~9.3~~ 9.2 billion gallons per day (BGD). Ground-water withdrawals accounted for ~~0.5~~ 0.6 BGD. Even during dry years such as 1988, only ~~5.9%~~ about six percent of the total reported water use in the state was from ground-water sources.

Water use information ~~currently~~ available to the department indicates that approximately ~~one-third~~ 12% of the total registered ground-water withdrawal capacity ~~is being~~ was utilized in ~~any given year~~ 2006. Even during the drought of 1988, only about 41% of the total capacity was reportedly withdrawn. Although some facilities that rely solely upon ground water did experience water supply problems during 1988, the shortages were typically a function of inadequate distribution, or a lack of water supply capacity from existing wells, rather than the result of ground-water depletion.

3. Statewide Ground-water Availability

In general, Indiana has an abundant supply of ground water. It is estimated that nearly one hundred trillion gallons are available in storage. With the exception of portions of the southern part of the state, ground water can be relied upon to furnish an adequate supply of water for much of the population. A map showing the generalized ground-water availability in the state is attached as Appendix V. If properly developed, this available ground-water supply, plus the annual recharge from precipitation, can provide Indiana residents with a dependable source of water to help meet existing and future needs.

The long-term supply of water to Indiana, in the form of precipitation, amounts to a statewide average of 38.0 inches per year. Approximately 3.0 to 3.6 inches of this annual rainfall, or a range of 143,000 to 171,000 gallons of recharge per day per square mile, is believed to be contributed to the ground-water resource of the state. Considering that Indiana has an area of 36,532 square miles, approximately 5.2 to 6.2 billion gallons of water is added to the state's ground-water resource each day. It should be noted that the ground-water withdrawals of ~~0.5~~ 0.6 BGD reported during ~~1990~~ 2006 represent only ~~8%~~ 10% to ~~10%~~ 12% of the daily "recharge" added by precipitation, and the total statewide ground-water withdrawal capability of ~~3.4~~ 4.6 BGD reported during ~~1990~~ 2006 is only ~~55%~~ 74% to ~~65%~~ 88% of this daily total.

Although current reported ground-water pumpage represents only about 10% of the annual recharge expected from precipitation, there are locations in the state where existing ground-water withdrawal facilities could exceed the recharge capability of aquifer systems. For example, in areas of northwestern Indiana where extensive irrigation pumpage occurs, the short-term recharge capability of an aquifer might be exceeded during the growing season and water is removed from storage. Under IC 14-25-4-12, the Department of Natural Resources is granted the authority to restrict significant ground-water withdrawal facilities if it is reasonably believed that continued ground-water withdrawals from the facility will exceed the recharge capability of the ground-water resource of an area. To date, the department has restricted pumpage on only one occasion under this specific provision of the law where extensive agricultural irrigation was occurring in Jasper and Newton Counties during the summer of 1988. Because of the seasonal nature of irrigation pumpage, ground-water levels typically recover prior to future growing seasons, and restrictions are only temporary.

4. Potential Limitations to Development

In those parts of the state where significant development of the ground-water resource is possible, wells could be installed in order to meet emergency and long range water needs. The development of the ground-water resource for public water supply however may be hampered due to the current permitting process that allows for a significant amount of public input concerning the siting of new wells or well fields. As a result, emergency ground-water development may be effected (or be significantly delayed) for reasons other than the availability of the resource itself.

While not generally applicable to the emergency development of the ground-water resources, consideration should be given to how much water can be safely pumped from an aquifer system, or the determination of its “safe yield”. The meaning of “safe yield” originally had only hydrogeologic considerations, but has evolved into a term that now involves hydrogeologic, economic, environmental and legal concerns. In order to determine the impact caused by increased development of the state’s ground-water resource, and whether the pumpage would exceed the safe yield of a particular aquifer, pumping tests and analytical or numerical models should be utilized. Pumping tests and analytical models have the potential to provide general insight into the impacts caused by ground-water withdrawals.

B. Utilization of Minimum ~~Stream Flows~~ Streamflow

IC 14-25-7-14 authorizes the Natural Resources Commission to determine and establish the minimum flow of streams. While the statute does not define minimum ~~stream flows~~ streamflow it suggests that in establishing such values, consideration should be given to the varying low flow characteristics of the streams of the state and the importance of instream and withdrawal uses, including established water quality standards and public water supply needs. In determining a minimum ~~stream flow~~ streamflow, perhaps the most critical determination is the amount of flow needed to sustain the instream uses on a given stream. Historically, in Indiana the ~~stream flow~~ streamflow equivalent to the 7Q10 (lowest seven (7) day average flow having a ten (10) year recurrence interval) could be considered to be the minimum ~~stream flow~~ streamflow. This value is a critical factor in determining the level of treatment required for discharges into the state’s rivers and streams. Since this criteria is critical to protecting water quality and little attention has been directed at assessing the minimum flow needed to sustain other instream uses in Indiana, the 7Q10 is commonly looked at as the minimum acceptable ~~stream flow~~ streamflow.

Numerous methods exist to evaluate the instream flow requirements for other purposes such as fisheries or recreation. While much work has been done on this issue, particularly in other states, none appears to be clearly applicable to Indiana.

In 1990, the Department entered into a contract with Purdue University to assist in the development of instream flow criteria for Indiana. Instream flow requirements in Indiana include the flow required to maintain fish habitat, recreation, water quality and hydropower generation. The Purdue study concluded that the instream flow requirements sufficient to maintain fish habitat are usually the highest of all instream flows in Indiana. For instream flow requirements for waste assimilation and water quality maintenance it was concluded that: (1) a flow corresponding to 7Q10 is satisfactory to meet water quality standards at all but four of 25 locations analyzed; (2) a low flow statistic of 61Qmed is satisfactory to meet water quality standards at all twenty five (25) stations; (3) during the summer season ammonia toxicity is more important than dissolved oxygen in determining instream low flow required to maintain water quality; and (4) during the winter season ammonia toxicity alone dictates the minimum instream low flow required to maintain water quality.

The Purdue study offered the following recommendations:

(1) To maintain a satisfactory fish habitat it is recommended that the Indiana Department of Natural Resources evaluate and implement the following instream flow criteria: (1) net withdrawal from the stream may be permitted if the flow is higher than the highest instream flow required for fish survival. From streams with basin areas exceeding 1500 square miles, withdrawal may be permitted if flows are greater than 61Qmed (May-October) (or Q80%); (2) If flows less than 61Qmed (May-October) (or Q80%) occur, net withdrawals may be restricted but not prohibited. From streams receiving low groundwater contributions and with basin areas less than 1500 square miles, net withdrawals may not be permitted if flows are less than 61Qmed (May-October) (or Q80%); (3) No net withdrawals are acceptable if the flow is less than annual 7Q10.

(2) To maintain water quality it is recommended that the Indiana Department of Natural Resources implement the following instream flow criteria: (1) Net withdrawal from a stream may be permitted if the flow is higher than the highest instream flow required for maintenance of water quality. Withdrawal may be permitted if flows are greater than 61Qmed (May-October); (2) If flows are less than 61Qmed (May-October), withdrawal may be restricted but not prohibited; (3) If flows are less than 7Q10, withdrawals may be permitted, but are not recommended.

The report refers to 61Qmed (May-October) which is the median flow estimated by using the lowest 61-day flows occurring over the May to October period of each year. These flows are approximately equal to the flows which are exceeded 80% of the time, referred to as Q80%. The Q80% value is easier to determine based on existing data and has therefore been substituted for 61Qmed.

Based on the Purdue Study the following conclusions can be reached:

(1) A ~~stream flow~~ streamflow equivalent to Q80% seems to be the desirable minimum flow to be kept in streams to maintain the instream flow requirements in Indiana. Net withdrawal from a stream should perhaps be restricted but not prohibited when ~~stream flows are~~ streamflow is lower than Q80%.

(2) A ~~stream flow~~ streamflow equivalent to 7Q10 (lowest seven (7) day average flow having a ten (10) year recurrence interval) seems to be the absolute minimum flow to be kept in streams to maintain instream flow requirements in Indiana. Net withdrawal from the

stream should be prohibited when ~~stream flows~~ ~~are~~ streamflow is lower than 7Q10 unless absolutely necessary to protect the public health, welfare or safety.

(3) In streams receiving low ground water contributions and with drainage areas less than 1500 square miles and when water quality is an issue (presence of a significant amount of effluents in the stream reach), it may be necessary to adopt a stricter threshold value than 7Q10 as the absolute minimum ~~stream flow~~ streamflow.

(4) It is important to note that the instream flow criteria purposefully refer to net withdrawals and not necessarily to total withdrawals. This means that water users may withdraw water from a stream at any time so long as they return the same amount of water to the stream in close proximity to its intake point without a significant degradation in its water quality. Such a scenario can occur only in the event the user has a supplementary source of water (such as an offstream reservoir) so that the consumptive uses can be compensated for. Therefore, before imposing restrictions, users should be encouraged and given the chance to plan and develop standby offstream water sources if they cannot tolerate restrictions or possible shutdown of their water withdrawals.

B. Use of Water in Lakes, Reservoirs and Streams

1. Lakes

There are over 500 natural lakes in the State of Indiana containing an undetermined amount of water. Most of these lakes are developed and many have been stocked with fish by the Department of Natural Resources. Many have a water level which has been established by court action and the Department is obligated to maintain that level. ~~IC 14-26-2-6 requires that a permit must be obtained from the Department prior to changing the level or shoreline of the lake.~~ It should be noted that these lakes are a source of raw water and only a few of these lakes currently are a part of the water supply system of any community. The Natural Resources Commission has historically allowed water withdrawals from these lakes only when their water levels were above their legally established normal level.

2. Reservoirs with State Owned Water Supply Storage

The State of Indiana owns water-supply storage in Brookville, Patoka and Monroe Reservoirs. The state has contracts to sell water to various parties from each of these reservoirs, either for direct withdrawals from the reservoir or for release for water withdrawals downstream of the reservoir. Uncontracted water supply is available at each reservoir and could be made available for allocation if the need arises. The staff of the Division of Water, DNR has estimated the uncontracted yield remaining at each of these reservoirs. This raw water could be made available to communities with supply problems. At each of these reservoirs there is at least one utility which has a treatment facility to purify raw water. It is possible that excess treated water could be provided to communities with water supply needs. As a part of this plan, contacts will be made with these utilities to ascertain the additional amounts of treated water which might be provided to communities in need. Raw water could also be released from the reservoirs to protect water quality or provide raw water to users downstream of the reservoirs.

IC 14-25-2 sets forth the criteria whereby the State may enter into a contract to sell water from these reservoirs. As now written, the process to accomplish this can take six months or longer. Therefore, for purposes of this plan, statutory changes would be needed to authorize the Department to quickly enter into short term contracts to address the water supply problems which might be associated with a drought.

It should be noted that additional utilization of the water supply storage of these reservoirs will produce lower levels thereby increasing the likelihood of having negative impacts on the other areas of interest to the Department such as, use of boat ramps, damage to fisheries, wetlands, etc.
3. Flood Control Reservoirs

As a part of this plan, contact will be made with the U.S. Army Corps of Engineers to ascertain if raw water supply could be made available from several Corps' reservoirs in the Upper Wabash River Basin. These reservoirs were built for flood control purposes but have a summer pool which is maintained. Winter pool levels are lower than summer levels and, therefore, releases could be initiated early if water supply is critical. Water in these reservoirs could be used for transport to communities or for release to meet water withdrawal or water quality needs downstream of the reservoirs.

XI. Data Needs and Plan Review

Throughout the process of developing this plan numerous comments were made regarding the inadequacy of data in selected areas. Specific concerns included the groundwater data base, new data generated by well head protection programs, inadequate number of gaging stations, the need to complete the Department's basin studies, etc. A number of these deficiencies make it difficult to be more specific regarding the actions which will be mandated during a water shortage. As years go by the data available will increase and could allow for the development of more definitive response plans to the consequences of a water shortage. Therefore it is recommended ~~that in developing legislation which will establish a standing Water Shortage Task Force, the legislation should require~~ that the Task Force review the contents of this plan and update or revise it ~~as needed. The time period should be~~ every two years at a minimum or every five years as a maximum.

APPENDIX I

IC 14-25-14

Chapter 14. Water Shortage Task Force

IC 14-25-14-1

"Task force"

Sec. 1. As used in this chapter, "task force" refers to the water shortage task force established by section 2 of this chapter.

As added by P.L.112-2006, SEC.2.

IC 14-25-14-2

Task force established; purposes; reports

Sec. 2. (a) The water shortage task force is established for the following purposes:

(1) To implement the 1994 water shortage plan when necessary.

(2) With the involvement of affected parties, to update, expand, and revise the 1994 water shortage plan to include a low flow and drought priority use schedule.

(3) To accomplish the following:

(A) Establish procedures to monitor, assess, and inform the public about the status of surface and ground water shortages for all uses in all watersheds, especially shortages due to drought.

(B) Recommend a state policy on desired baseline flow maintenance for in-stream uses.

(C) Recommend a state policy for promoting water conservation.

(D) Prepare a biennial report on the status of current surface and ground water withdrawals in all Indiana watersheds that:

(i) distinguishes between consumptive and nonconsumptive withdrawals; and

(ii) notes areas of current or likely water shortage challenges based on current usage trends and current knowledge of hydrology.

(E) Collect information concerning illustrative past and current surface water and ground water allocation conflicts in the state and how conflicts have been resolved.

(4) To encourage units of local government to:

(A) pass ordinances that:

(i) promote water conservation; and

(ii) establish priorities of water usage during droughts, including suggested model ordinances for counties and municipalities; and

(B) publicize the need for local communities to be prepared for droughts.

(5) To prepare an annual report on progress in implementing the tasks listed in subdivisions (3) and (4).

(b) The task force shall provide the reports required under subsection (a) to:

(1) the water resources study committee established by IC 2-5-25-1; and

(2) the legislative council, in an electronic format under IC 5-14-6.

As added by P.L.112-2006, SEC.2.

IC 14-25-14-3

Membership

Sec. 3. (a) The task force consists of ten (10) individuals, not more than five (5) of whom may be members of the same political party, representing the following interests, appointed by the director for four (4) year terms:

(1) Key water withdrawal users, including the following:

(A) Public water supply utilities.

(B) Agriculture.

(C) Steam electric generating utility companies.

(D) Industrial users.

(2) Academic experts in aquatic habitat and hydrology.

(3) Municipalities.

(4) Key stakeholders, including the following:

(A) Environmentalists.

(B) Consumer advocates.

(C) Economic development advocates.

(D) The public.

(b) The director shall serve on and is chairperson of the task force. The department shall provide staff support for the task force.

As added by P.L.112-2006, SEC.2.

IC 14-25-14-4

Agency representatives

Sec. 4. (a) Each of the following state agencies shall designate a representative to advise the task force:

(1) The department.

(2) The department of environmental management.

(3) The department of homeland security.

(4) The Indiana state department of agriculture.

(5) The state department of health.

(b) In addition to the representatives set forth in subsection (a), the director may invite representatives of other state and federal agencies as appropriate to advise the task force.

As added by P.L.112-2006, SEC.2. Amended by P.L.120-2008, SEC.10.

IC 14-25-14-5

Majority vote required for action

Sec. 5. The affirmative votes of a majority of the voting members of the task force are required for the task force to take action on a measure.

As added by P.L.112-2006, SEC.2.

IC 14-25-14-6

Initial meeting; activities; time frame

Sec. 6. At its first meeting, the task force shall establish:

(1) a list of its activities; and

(2) the time frame under which it will implement the tasks listed in section 2(a)(3) and 2(a)(4) of this chapter.

As added by P.L.112-2006, SEC.2.

APPENDIX II

Water Shortage Task Force - 2006

Task Force Position	Name	Title & Affiliation
Chair	Robert E. Carter Jr.	Director, DNR
Chair designee	Ron McAhron	Deputy Director, DNR
Public Water Supply Utilities	William L. Etzler	V.P. and Regional Manager, Aqua Indiana, Inc.
Agriculture	James Facemire	Farmer; Johnson County SWCD Board of Supervisors
Steam electric generating utilities	James F. Butcher	Manager of Environmental Affairs, Indiana Michigan Power
Industrial users	Michael P. Brooks	Environmental Engineer, Steel Dynamics, Inc. –engineered Bar Products Division
Academic experts in aquatic habitat & hydrology	Dennis Wichelns, Ph.D.	Exec. Dir. & Director of Economics Programs, Rivers Institute at Hanover College
Municipalities	Carlton Curry	Director of Contracts & Operations, City of Indianapolis, Dept. of Waterworks
Environmentalists	John R. Goss	Executive Director, Indiana Wildlife Federation
Consumer advocates	Scott Bell	Office of the Utility Consumer Counselor, Director of Water/Wastewater
Economic development advocates	Vince Griffin	Vice President, Energy & Environmental Affairs, Indiana Chamber of Commerce
Public	Jack Wittman, Ph.D. CGWP	President, Wittman Hydro Planning Associates, Inc.

Water Shortage Agency Advisors - 2006

Indiana Department of Natural Resources	James Hebenstreit	Assistant Director, Division of Water
Indiana Department of Environmental Management	Martha Clark Mettler	Deputy Assistant Commissioner, Office of Water Quality
Indiana Department of Homeland Security	John Steel	Homeland Security Planner/Natural Hazards
Indiana State Department of Agriculture	Tammy Lawson	Assistant Director, Regulatory Affairs & Soil Conservation
Indiana State Department of Health	Howard Cundiff	Director, Consumer Protection Division
Indiana Utility Regulatory Commission	David Hardy	Chairman
Purdue University	Dev Niyogi, Ph.D.	State Climatologist
Purdue University	Ron Turco, Ph.D.	Assistant Director, Environmental Sciences
U.S. Army Corps of Engineers	Amy Sharp	Outreach Coordinator
U.S. Geological Survey	Scott Morlock	Chief, Hydrologic Data Section
National Weather Service	John Ogren	Meteorologist

APPENDIX III

Indiana Suggested Model Ordinance

Preamble

The Local Unit of Government recognizes that water is a scarce and valuable natural resource that should be used wisely by all residential, commercial, industrial, agricultural, and recreational consumers. Water is needed to maintain in-stream flows in rivers and creeks, provide aquatic habitat, and maintain the diversity of plant and animal species. Consequently, all citizens should practice wise water use during periods of water abundance and water shortage. Wise water use will enable the Local Unit of Government to maximize the many values that water provides to all users, while minimizing the frequency, duration, and severity of water shortages. The Local Unit of Government believes also that the best way to achieve wise water use among all consumers is to provide the information, incentives, and technical support needed to motivate adoption of desirable water management practices. The appropriate combination of information, incentives, and technical support shall be considered to be the Local Unit of Government "Water Management Strategy" that will be implemented in perpetuity, subject to modification through the legislative process, over time. The Local Unit of Government goal is to implement and promote a comprehensive plan that encourages wise water use in all years, regardless of whether annual or seasonal water supplies are abundant or scarce. Implementing the Local Unit of Government Water Management Strategy will:

1. Increase public awareness regarding the general scarcity and value of water resources,
2. Improve public knowledge and understanding of methods for using water wisely,
3. Provide economic incentives for all consumers to implement desirable water management practices,
4. Enhance the sum of net benefits (both financial and non-financial) obtained from the local and regional water resources,
5. Reduce the frequency, duration, and severity of seasonal and other short-term water shortages, and
6. Promote economic development that is consistent with the Local Unit of Government long-term water supply outlook.

The Local Unit of Government recognizes that seasonal and other short-term water shortages likely will occur in the future, with or without implementation of a Water Management Strategy. When shortages occur, it may become necessary to implement measures that enable the Local Unit of Government to allocate scarce water supplies among competing users. For example, it may become necessary for the Local Unit of Government to ensure that hospitals and public safety agencies are given priority access to water supplies, while other users are given lower priority. It also may become necessary for the Local Unit of Government to impose restrictions on selected uses of water, such as irrigating lawns or washing cars. The Local Unit of Government also should seriously consider raising the price of water substantially during shortages to encourage meaningful reductions in water use.

This Ordinance describes a suite of measures including good management practices at all times, potential price increases for water during times of severe shortage, and enforced rationing during periods of extreme water shortage. While some of these measures may not apply in all locations or situations, the purpose of the measures is to encourage wise use of the resource and to minimize the negative impacts of seasonal or short-term water shortages. The Local Unit of Government's goal is to develop and implement a comprehensive Water Management Strategy that will minimize the need for more restrictive measures described in the Ordinance. The Local Unit of Government recognizes that information, incentives, and technical support are much more effective in encouraging wise water use than mandates regarding either voluntary or required changes in water use. Mandates will be implemented only as a last resort or temporary approach to allocating water during periods of severe water shortage. At all other times, the Local Unit of Government expects residents to use water wisely, and the Local Unit of Government will continually assist all water consumers in implementing desirable water management practices, as described in the Local Unit of Government's Water Management Strategy.

An ordinance for the effective management of water furnished by the Local Unit of Government

BE IT ORDAINED by the Local Unit of Government

WHEREAS, both natural and man-made conditions, may arise or occur which cause a temporary shortage of water; and

WHEREAS, such conditions may affect the Local Unit of Government public water system's ability to provide an adequate supply of water or where the public water supply may be unable to maintain adequate water pressure in the delivery system; and

WHEREAS, in such event it is imperative to the well being of the residents of the Local Unit of Government that uses of water not essential to the health, welfare and safety be restricted,

NOW THEREFORE, BE IT ORDAINED by the Local Unit of Government

Section 1. *Application.* This ordinance shall apply to all persons, firms, partnerships, corporations, company or organizations connected to the Local Unit of Government public water system or using water therefrom (hereafter, users).

Section 2. *Declaration of Need.* Upon determining that the Local Unit of Government public water system is in a condition of water shortage, the Local Unit of Government shall declare a water conservation emergency and establish the appropriate measures and the duration thereof.

Section 3. *Conservation Measures*. Practices that conserve water should be used at all times. Examples of conservation measures include:

a. Judiciously sprinkling, watering, or irrigating shrubbery, trees, grass, ground covers, plants, vines gardens, vegetables, or any other vegetation; Eliminating wasteful sprinkling of impervious surfaces, such as streets and sidewalks;

b. Limiting water use while washing trucks, trailers, mobile homes, railroad cars or any other type of mobile equipment;
c. Limiting water use while cleaning sidewalks, driveways, paved areas, or other outdoor surfaces;
d. Repairing or replacing leaking water fixtures and service lines;
e. Using appliances such as clothes washers and dishwashers only when they are full;
f. Turning off the water while brushing teeth or shaving;
g. Using a higher lawnmower setting to provide natural ground shade and promote the soil's water retention;
h. Washing cars with a bucket of soapy water and using a nozzle to stop the flow of water from the hose between rinsing;
i. Covering swimming pools when not in use to reduce evaporation.

Section 4. *Voluntary Conservation.* During moderate water shortages users shall be requested to reduce water consumption by practicing voluntary conservation. The Local Unit of Government shall identify reasonable and meaningful conservation techniques and provide such information to users. The Local Unit of Government may also implement conservation pricing and prohibitions to encourage water conservation.

Section 5. *Mandatory Conservation.* During severe water shortages users shall be prohibited from selected water uses subject to reasonable terms, times and conditions as the governing body shall adopt and append to this document.

Section 6. *Rationing.* In addition to mandatory conservation measures users shall be limited during extreme water shortage to water use by the following schedule:

a. Residential use shall be limited to ________ gallons per residential unit per day.
b. Business, commercial, agricultural, and industrial users shall be limited to the volume of water deemed to be essential.

Section 7. *Exceptions.* The Local Unit of Government shall establish rationing exemptions necessary to provide for the maintenance of adequate health, safety, and sanitary conditions.

Section 8. *Notice.* Notice of the need for voluntary conservation measures shall be issued in a local newspaper of general circulation or other means such as radio and television as deemed appropriate by the governing body. Notice shall be effective upon issuance.

Notice of mandatory conservation or rationing shall be by first class United States mail, or by other door to door distribution to each current user, and by electronic and print media. Notice shall be deemed effective at the conclusion of door to door distribution or at noon of the third day after depositing notice in the United States mail.

Section 9. *Enforcement.* Any user who violates Section 5 or 6 of this ordinance may be punished by a fine of not more than $2,500 (*see IC 36-1-3-8 (a)(10)(B)).* Each day of violation shall constitute a separate offense. In addition to, or in the alternative to, a fine, water service may be terminated for any user who violates Section 4 or 5 of this ordinance

Section10. *Effective date.* This ordinance shall be in full force and effect upon passage.

Passed and adopted by the Local Unit of Government on the ____ day of ___________, 20__.

Glossary of Model Ordinance Terms

Local Unit of Government: Any county or municipality having the ability to promulgate ordinances including those having enforceable penalties related to water use.

Voluntary Conservation: Compliance with a local unit of government's request to reduce water use**.**

Mandatory Conservation: Compliance with a local unit of government's imposition of requirements that are designed to reduce certain kinds and types of water use**.**

Water Rationing: Compliance with a local unit of government's imposition of restrictions that will reduce demand for water to a maximum allowable quantity within a finite time interval (e.g.; gallons per person per day).

Water Management Strategy: A plan adopted by a local unit of government together with its water resource manager or utility to reduce the demand upon both raw water supply and treated or finished water.

Treated Water: Water treated in a manner that it is suitable for human consumption or for another designated use.

APPENDIX IV

Review of Available Drought Indices

A discussion of readily available and useful data for identifying the onset and stage of a water shortage follows. Dr. Niyogi and Umarporn Charusambot of Purdue University present a comparison of the SPI and Palmer Drought Indexes.

Precipitation

The lack of precipitation is the principle factor involved in periods of drought. Precipitation records are the most useful and readily available data for monitoring water shortage conditions on a meteorological basis. Monthly precipitation data are available since the late 1890's for each of the nine National Weather Service climatic divisions in Indiana (Figure 1).

The two most significant characteristics of precipitation in relation to drought are the magnitude and duration of deficits. Precipitation deficits are the difference between actual precipitation and the long term average precipitation for the specified period. Determination of cumulative departures from the mean is one method of evaluating long term climatic or hydrologic trends. By use of this method, departures of the monthly mean from the long term mean monthly value are accumulated algebraically through the period of record and plotted against time. The plot of cumulative precipitation departures from mean precipitation can be constructed for the entire record, for the driest period, or for several dry periods in order to compare drought severity.

As a part of a report prepared by the United States Geological Survey, in cooperation with the Indiana Department of Natural Resources (Description and effects of 1988 drought on ground-water levels, streamflow, and reservoir levels in Indiana, U.S. Geological Survey Water Resources Investigations Report 91-4100), cumulative departures from mean monthly precipitation were calculated for each of the nine climatic divisions in Indiana for the years 1921 to 1989. A copy of the graph for Division 8 is shown ~~in Figure 3~~ on the following page. The slopes on the graphs from year to year are more descriptive than the vertical position. A rising or positive slope on the graph shows above average precipitation, whereas a declining or negative slope indicates below average precipitation. For example, the long-term record for Division 8 shows that from 1920 to 1930 there was a total excess (that which is above average) of about 30 inches, an average excess of about 3 inches per year. However, from about 1940 to about 1944, a historic drought occurred. During that 4-year period, the rainfall deficiency totaled about 48 inches, an average deficiency of about 12 inches per year. Periods with no discernible trends indicate generally average precipitation with both wet and dry years. For the period of 1987-89 the graphs of Indiana's nine climatic regions indicate a moderate drought of relatively short duration when compared to previous records of negative departures. For example, longer, more severe periods of negative departures (declining slopes) occurred during 1941-49 and 1964-75.

Comparison of precipitation deficits to the period of record and the graphs discussed above, in conjunction with other data sources, will provide a useful tool in identifying the possible onset and severity of future drought events.

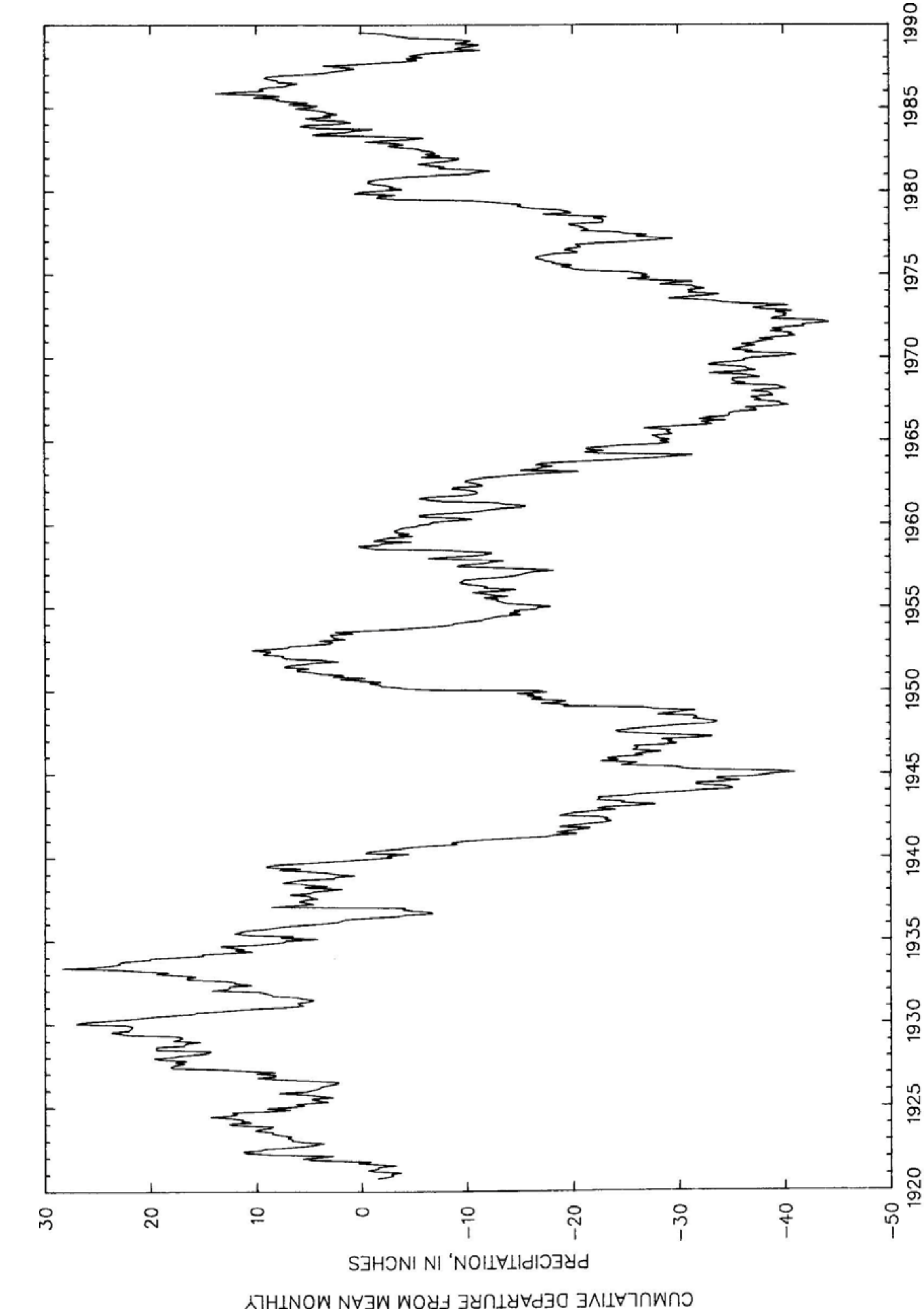
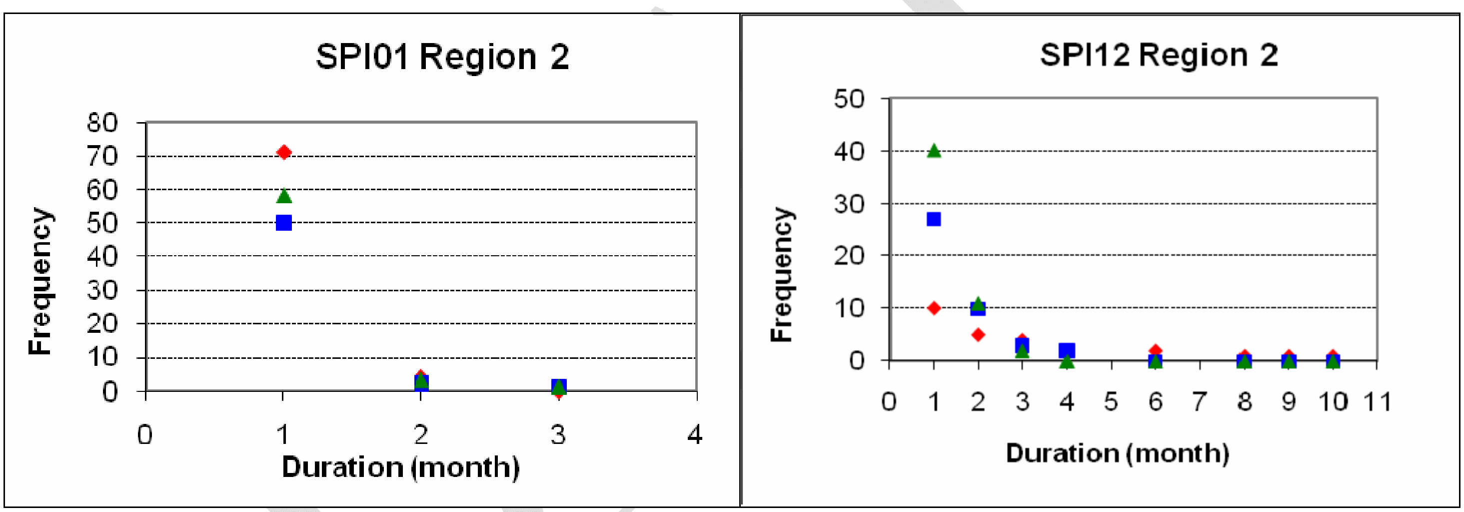


Figure 3.--Cumulative departure from mean monthly precipitation for climatic division 8, water years 1921–89 (data from National Oceanic and Atmospheric Administration, Climatic Data Center).

The Standardized Precipitation Index

Agricultural/ Meteorological drought is a result of deficient rainfall (precipitation). The SPI (Standardized Precipitation Index) has been used to quantify the deficit of precipitation. It can be computed at different time scales from less than 1 month to 48 months or more. The calculation time period depends on the user's application. Short-term SPI can be used to detect agricultural drought, and long-term SPI can be used for water supply management. The SPI value is derived from the inverse value of the cumulative probability function of the observed precipitation distribution. The negative value from zero shows the severity of dryness. The positive value of SPI shows the degree of wetness. The SPI value normally ranges from (-2) – (+ 2). An index of (+2) indicates extremely wet; (1.5) – (1.99) very wet; (1.0) – (1.49) moderately wet; (0.99) – (- 0.99) near normal; (-1.0) – (-1.49) moderately dry; (-1.5) – (-1.99) severely dry; (-2.0) or (less) extremely dry. The drought stage indices for Indiana as per SPI changes are as follows:

Stage	**SPI Index**
Normal	(0.99) – (- 0.99)
Drought Watch	(- 1.0) – (-1.49)
Drought Warning	(- 1.5) – (-1.99)
Drought Emergency	(- 2.0) – (< -2.0)



The figure above shows the frequency of drought occurrences in Climate Division 2. The figure shows that SPI detects drought emergencies more than the drought watch and/or warning when the time scale of SPI increases; drought warning frequency increases along time period.

The drought indices consider precipitation as the main factor in the drought calculation. Therefore, precipitation monitoring is at the heart of every drought index. All the indices rely on accurate and spatially representative rainfall observations. Estimation of water loss from evapotranspiration is also useful as it provides the information on effective precipitation available.

Selection of Appropriate Index

A National Climatic Data Center-led study (Comparing the Palmer Drought Index and the Standardized Precipitation Index; Journal of the American Water Resources Association, v. 34, no. 1) by Guttman (1998) compared the Palmer Drought Severity Index (PDSI) and SPI indices for drought analysis. The results show that the SPI 3 and 6-month lead (phase > 0) and perform better than PDSI. The 12-month SPI performs similarly to the PDSI. A Indiana drought frequency analysis conducted by the Indiana State Climate Office at Purdue University (Charusambot, Ph.D. dissertation in progress), shows that 665 events have occurred in which SPI 3-month identifies a drought watch, while PDSI still identifies normal conditions over Indiana. On the other hand, while SPI03 indicates 306 emergency drought events, PDSI still registers this event as a warning drought condition. On a 12-month time scale, the slope of consistency between PDSI and Palmer Hydrologic Drought Index (PHDI) with SPI12 has been increased which means the PDSI and PHDI indices have a higher consistency with SPI when the time scale increases.

The analysis concludes that over Indiana, SPI 01, 03, and 06 can be used as a trigger for short term droughts (meteorological drought) over PDSI and PHDI. SPI indicates more instances and increased intensity of drought information across all the Indiana climate divisions.

Agricultural drought generally considers soil availability to the crop and plant more than the precipitation deficit. The most significant factor for agricultural drought is the soil root zone water holding capacity. Therefore, the indicators often used to determine agricultural drought are the CMI and ZNDX indices. However, CMI has limitations due to its calculation considering the same soil texture and properties over all climate divisions. In addition, the CMI does not consider the water balance from landuse and landcover. Due to the limitations of CMI, the availability of soil moisture / soil temperature data will assist in using some of the crop indices that may be of interest to agriculture applications. Since SPI is also used in national drought monitoring as well as in neighboring states such as Illinois, the products and assessments made both at the national and regional scales become relevant to the state for determining drought-related actions. Also, like any single measure trying to capture the complex nature of drought, SPI will have its limitations. *Therefore, SPI is recommended as the drought index for Indiana. This index should be used in addition to the information available from the US drought monitor and input from agencies such as the State Climate Office, National Weather Service, United States Geological Survey, and other local agencies to accurately assess the threat of drought.*

Ground-water Levels

Of note when assessing the impact of a water shortage on ground-water levels is the fact that ground-water levels typically respond to precipitation at a slower rate than surface water sources. In drought events groundwater levels will be lowered through above normal demands on aquifer systems as a result of diminished recharge and increased withdrawals by users.

The United States Geological Survey (USGS) in cooperation with the Indiana Department of Natural Resources (IDNR) maintains a ground-water monitoring well network which includes approximately ninety (90) wells. These wells are located to provide a regional assessment of the ground-water resource or to monitor ground-water levels in areas where potential conflicts and/or competing uses may occur. While the period of record for most of these wells is relatively short (15 to 25 years), comparison of current water levels with the period of record does provide some basis for assessing the potential severity of droughts. It should be noted that problems may occur with wells utilizing smaller aquifer systems or as a result of increased withdrawals which may not be recognized as a problem based on the observation well network.

Ground-water levels throughout the State were moderately affected by the 1988 drought. Even before 1988, water levels had begun their decline. During October, November, and December of 1987, many USGS/IDNR monitoring wells recorded below-average water levels. Below-average precipitation throughout the State aggravated the declining levels for most of the first 9 months of 1988. Statewide, above-average precipitation was recorded in only February and July. In July 1988, a ground-water emergency was declared by IDNR for parts of Jasper and Newton Counties in northwestern Indiana where large scale irrigation is practiced. During the emergency, high-capacity wells (wells that withdraw water at a rate of 70 gal/min or more) were prohibited from pumping on weekends. These restrictions were mandated for 90 days.

Streamflow

Twenty-seven selected stream gaging stations were monitored on a weekly basis during the summer of 1988. Weekly ~~stream flows were~~ streamflow was compared to monthly mean ~~stream flows~~ streamflow for the summer months and to the 7Q10 discharge. The 7Q10 discharge is the stream discharge that would occur for seven consecutive days once every 10 years. This value is utilized by the Indiana Department of Environmental Management for purposes of determining permit requirements for discharges to the state's rivers and streams. ~~Stream flow~~ Streamflow data for gaging stations may be analyzed statistically in a number of different ways. In a report concerning the 1988 drought the United States Geological Survey utilized data from twenty-four gaging stations to graph cumulative departures of monthly mean streamflow for each station's period of record. Cumulative departures of monthly mean ~~stream flow~~ streamflow for each of the stations can be calculated by computing the difference between each monthly mean value and that month's long term mean monthly value. The cumulative departures can be plotted to provide a graphical representation of the relative severity of a drought as compared to the entire period of record. Cumulative departure from the mean is one method of evaluating relative severity and long term trends. The slope and length of the lines and the change in their positions from year to year are more important than the vertical location of the lines on the graphs. A positive slope indicates that ~~stream flow~~ streamflow during that period was generally above average, whereas a negative slope indicates a period when ~~stream flow~~ streamflow was below average. A sample plot for a gage on the White River at Nora is shown in the figure on the following page.

While the above mentioned method may be valuable for evaluating the relative severity of droughts, it is inadequate to establish a trigger level for drought response. Monthly flow duration curves appear to be the most useful at this time. They show graphically the percent of time given flows are equaled or exceeded on a monthly basis during the period of record. By using monthly flow duration curves, seasonal variability is considered. Various ranges can be established equivalent to water shortage stages. ~~Flows that are equaled or exceeded up to 75% of the time are considered to be in the normal condition. Flows that are equaled or exceeded more often (lower~~

~~flows) are used for establishing drought conditions.~~ Streamflow at the 25th percentile means that streamflow is only 25% of the historical average streamflow for that particular month. Lower percentiles correspond to increasingly lower streamflow and drought conditions.

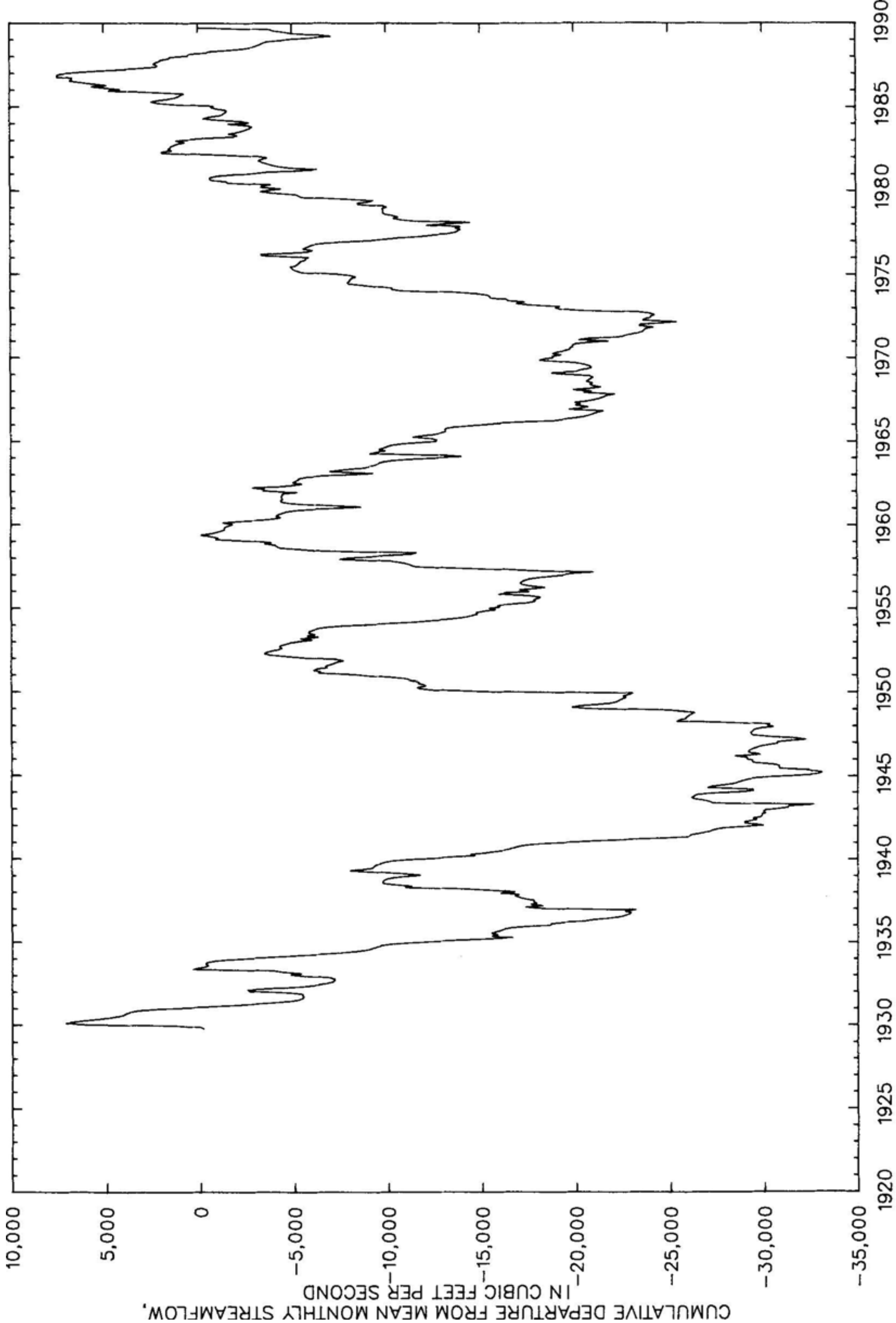


Figure 4.--Cumulative departure from mean monthly streamflow for White River near Nora (03351000), water years 1930-89.

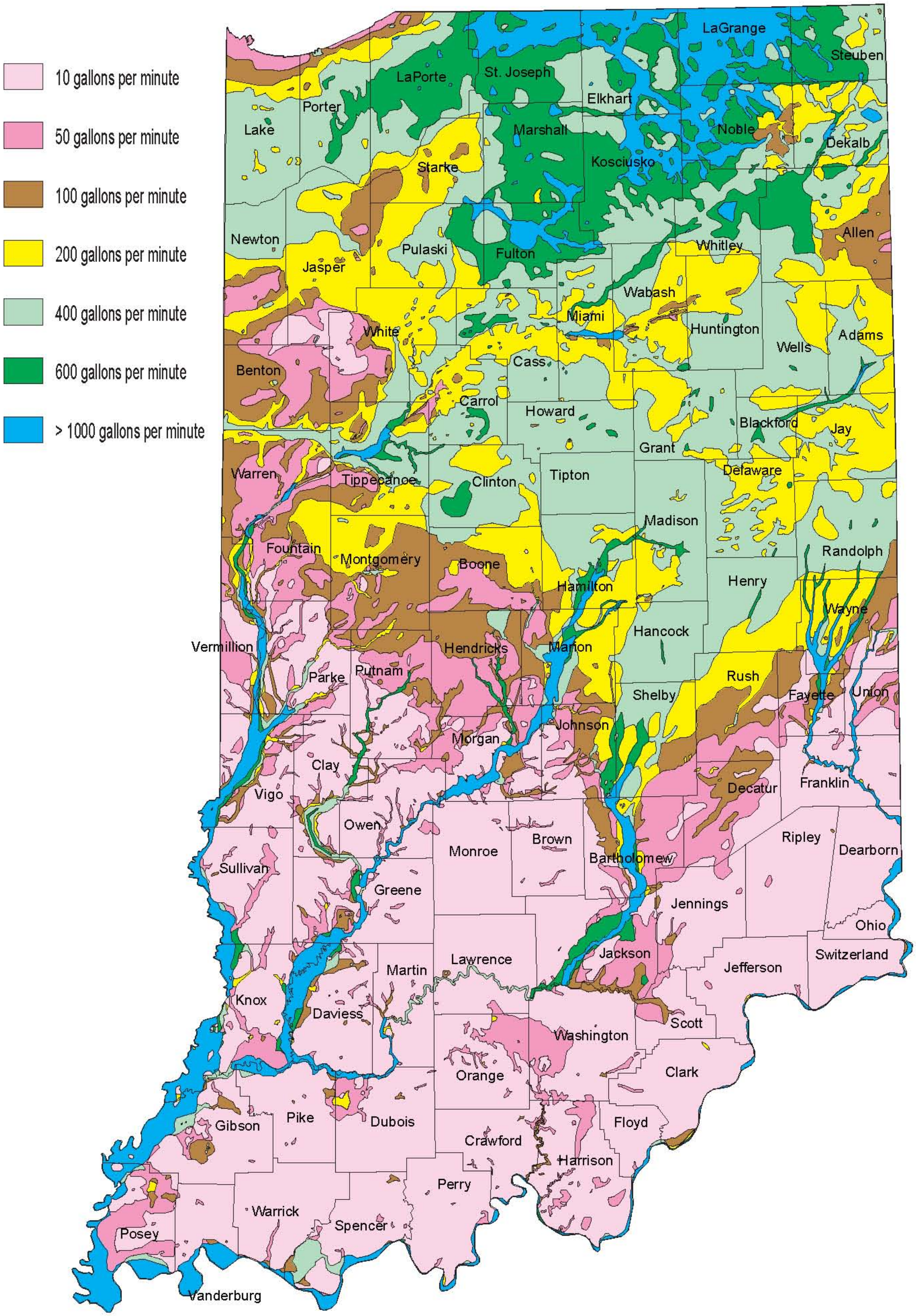
Reservoir Levels

Indiana’s reservoirs are an important part of the State’s water resources. Deficit precipitation, high temperatures, and low streamflow had adverse effects on these reservoirs during 1988 and 1989. Water supplies for many towns and cities were threatened as water levels declined. Many municipalities dependent on reservoirs for public water supply called for voluntary reductions in water use. The quality of water decreased at some reservoirs as low levels coupled with high temperatures resulted in increased aquatic growth and reduced dissolved oxygen levels. Recreation activities at most of the State’s reservoirs were affected. Many beaches and marinas were left dry as water levels fell. Reduced areas of open water resulted in increased congestion for boaters and skiers. With fewer people using recreational facilities, owners and operators suffered variable amounts of economic losses. At the present time the data base on reservoir level fluctuations relative to precipitation deficits is considered to be inadequate to be used as a predicative tool in identifying the onset of a water shortage event.

APPENDIX V

State Ground-Water Availability Map

Generalized Ground-Water Availability



Ground-Water Availability

Ground-water capabilities vary widely in the state, ranging from as little as 10 gallons per minute (gpm) or less to over 2,000 gpm to properly constructed, large-diameter wells. The availability of ground-water on a statewide basis is shown on the reverse side. This generalized ground-water potential map portrays the range of probable maximum yields which can be expected from a properly constructed large-diameter well penetrating the full thickness of the aquifer. The ground-water yield potential represents a consolidation of both unconsolidated and bedrock aquifers with similar water yielding characteristics.

Potential Yield Categories

There are seven ground-water yield categories in Indiana as shown on the Generalized Ground-Water Availability Map. Category 1 shows the poorest water yielding areas with well yields usually less than 10 gpm. Dry holes are common in many of these areas. Category la depicts areas of marginal ground-water supplies with well yields generally less than 10 gpm; however yields of 50 gpm occur in localized areas. Some dry holes may also occur in these areas.

Category 2 represents areas of limited groundwater availability but slightly better than categories 1 and la. Wells are expected to produce between 5 to 100 gpm, although yields may be less in some areas. Category 3 includes areas with fairly good ground-water conditions, with yields from 100 to 200 gpm. Category 4 indicates those areas with wells capable of producing yields from 200 to 400 gpm. Category 4a identifies areas with very good ground-water conditions with well yields usually between 400 to 600 gpm. Category 5 delineates those areas where wells may potentially yield 1,000 or more gpm.

The various categories of ground-water yields are only a measure of the relative productivity of the several aquifer systems. These yield potentials do not indicate that an unlimited number of wells of the specified yield can be developed in any given location. Detailed studies including exploratory drilling and test pumping should be conducted to adequately evaluate the groundwater resource in any given area and the resultant change in water level as produced by the pumpage.

Regional Ground Water Conditions

Northern Indiana

In general, the ground-water resource of northern Indiana can be classified as being good to excellent, and exclusive of some areas in northwestern Indiana, well yields of from 200 to 2,000 gpm or 0.3 to 2.8 million-gallons-per-day (mgd) can be expected in most areas. Major areas of ground-water availability are found where the productive Silurian-Devonian bedrock aquifer system underlies large areas and where deposits of glacial material up to 500 feet in thickness contain highly productive inter-till sand and gravel aquifers. A number of major outwash plain and “valley train” sand and gravel deposits are associated with the St. Joseph, Elkhart, Pigeon, Fawn, Eel, and Tippecanoe River valleys. These sources are capable of large ground-water production. Wells with capacities greater than 400 gpm, or 0.6 mgd, are quite common.

Central Indiana

In the central portion of the state ground-water conditions range from fair to good. Well yields from 100 to 600 gpm or from 0.15 to 0.9 mgd are typical for many large-diameter wells. Both outwash sand and gravel and limestone and dolomite bedrock aquifers are tapped to meet the needs of the users of large volumes of water. Major ground-water sources are present in the valleys of the West Fork of the White, Whitewater, Eel, and Wabash Rivers, and in portions of the valleys of Eagle, Fall, and Brandywine Creeks and the Blue River. Bedrock aquifers in the Silurian-Devonian limestone sequence are also frequently utilized, and wells in these deposits are capable of yielding from 100 to 600 gpm or 0.15 to 0.9 mgd. Locally, thicker inter-till sand and gravel aquifers are present that are capable of meeting small municipal and industrial needs. These sources are normally capable of yielding up to 300 gpm.

Southern Indiana
Many areas of the southern part of the state are particularly lacking in ground water, and only limited amounts, generally less than 10 gpm, are available to properly constructed wells. In these areas the major sources of ground water are present in the sand and gravel deposits of the stream valley aquifers. These sand and gravel aquifers are extensively tapped by a number of municipalities, rural water systems and irrigation users. The valleys of the Eel, Ohio, Wabash and Whitewater Rivers as well as the East Fork, West Fork and main stem of the White River are underlain by thick deposits of outwash sand and gravel capable of supplying over 1,000 gpm or 1.4 mgd to properly constructed, large diameter wells.

APPENDIX VI

Glossary of Terms

Working Draft of "Glossary of Terms" for the update of Indiana's Water Shortage Plan

October 23, 2008

7Q10: 7Q10 is set by environmental water standards. In short, it is the minimum quantity of ~~stream flow~~ streamflow necessary to protect habitat during a drought situation. This is the lowest ~~stream flow~~ streamflow for seven consecutive days that would be expected to occur once in ten years. (7Q50 would be expected to occur once every 50 years)

Anomaly: Difference between a given quantity or observation and its average value. This is the same as "departure from average." For example, if the average rainfall for June is 5 inches, but this year there is 100 inches of rainfall in June, then the anomaly is +95 inches.

Aquifer: An underground geological formation, consolidated or unconsolidated, that has the ability to receive, store, and transmit water in amount sufficient for the satisfaction of any beneficial use.

Climate: The general or typical atmospheric conditions for a place and/or period of time for at least a 30-year period. Conditions include rainfall, temperature, thunderstorms, ~~lightening~~ lightning, freezes, etc.

Climate Division: A region within a state that is reasonably homogeneous with respect to climatic and hydrologic characteristics. The State of Indiana is divided into 9 Climatic Divisions by the National Weather Service.

Climatology: (1) The description and scientific study of climate. (2) A quantitative description of climate showing the characteristic values of climate variables over a region.

Conservation: The use of water-saving methods to reduce the amount of water used for homes, lawns, farming, industry, and etc. thus securing water supplies for optimum long-term economic and social benefits.

Crop Moisture Index (CMI)- Derived form the Palmer Drought Severity Index to assess short-term crop water conditions and needs across major crop-producing regions. This index is a useful tool in forecasting short-term drought conditions. (See Palmer Drought Severity & Crop Moisture Indices)

Drought: There is no definitive definition of drought based on measurable processes; scientists evaluate precipitation, temperature, and soil moisture data for the present and recent past to determine drought status. Very generally, it refers to a period of time when precipitation levels are low, impacting agriculture, water supply, and wildfire hazard.

Forecast: A prediction of future conditions by analysis of data. For example, precipitation forecasts are based on meteorological data.

Ground water: All water occurring beneath the surface of the ground regardless of location or form.

Local Unit (of Government): Any city, town or other governmental unit having the ability to promulgate ordinances including those having enforceable penalties related to finished or raw water use.

Mandatory Conservation: Compliance with a local unit's imposition of requirement that are designated to reduce certain kinds and types of water use.

Mg: Million gallons

Mgd: Million gallons per day

National Climatic Data Center (NCDC): NCDC maintains the world's largest active archive of weather data. NCDC produces numerous climate publications and responds to data requests from all over the world. (See http://www.ncdc.noaa.gov)

National Oceanic and Atmospheric Administration (NOAA): NOAA's historical role has been to predict environmental changes, protect life and property, provide decision makers with reliable scientific information, and foster global environmental stewardship. Today NOAA's mission remains unchanged as it describes and predicts changes in the Earth's environment, and conserves and wisely manages the Nation's coastal and marine resources. (See http://www.noaa.gov)

National Weather Service (NWS): The National Weather Service (NWS) - provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure which can be used by other governmental agencies, the private sector, the public, and the global community. (See http://www.nws.noaa.gov)

Normal Precipitation: To understand whether precipitation and temperature is above or below normal for seasons and longer timescales, normal is defined as the average weather over 30 years. These averages are recalculated every ten years. The National Weather Service has just recalculated the baseline period for normal from 1961 to 1990 to 1971 to 2000. Since the cool decade of the 1960's has been replaced with the mild 1990's, normal temperatures in many areas have increased.

~~**Palmer Drought Severity Index (PDSI):** An indicator, based on temperature, precipitation, and soil type, of long-term deficits or surpluses of soil moisture.~~

~~**Palmer Drought Severity Index (PDSI):** An index that compares the actual amount of precipitation received in an area during a specified period with the normal or average amount expected during that same period. It was developed to measure lack of moisture over a relatively long period of time and is based on the supply and demand concept of a water balance equation. Included in the equation are amount of evaporation, soil recharge, and runoff and temperature and precipitation data.~~

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Palmer Hydrological Drought Index (PHDI): An indicator of long-term, hydrological drought based on impacts such as groundwater and reservoir levels.

Percent of Normal (Average): A comparison of conditions, such as precipitation or temperature, at any one place or time with the historical average of that condition.

Precipitation: Rain, snow, hail, sleet, dew, and frost.

Recharge: Net accumulation of water into an aquifer from sources such as precipitation, seepage, and injection.

Reclamation Drought Index (RDI): Similar to the Surface Water Supply Index, the RDI incorporates temperature as well as precipitation, snowpack, ~~stream flow~~ streamflow, and reservoir levels in order to define drought on a river basin level.

Reservoir: A pond, lake, or basin, either natural or artificial, for the storage, regulation, and control of water.

~~Stream flow~~ Streamflow: The total flow of water, or stream discharge, past a specified point in a stream channel, and for a specified period of time.

Surface water: All water occurring on the surface of the ground, including water in a stream, natural or artificial lakes, ponds, swales, marshes, and diffused surface water.

Treated Water: Water processed in a manner making it suitable for human consumption or for another designated use.

Voluntary Conservation: Compliance with a local unit's request to reduce water use.

Water Management Practices: The methods used by residents, business persons, farmers, and all others to ensure that water is used wisely and with minimal waste. Examples include using low-flow showerheads in homes, using sprinklers or drip irrigation systems in gardens, using low-volume washing equipment in businesses and ~~mother~~ other measures that enable water users to achieve their operational goals with minimal water use. It is essential that all residents use good water management practices at all time, while redoubling their efforts during periods of moderated and severe water shortage.

Water Management Strategy: A plan adopted by a local unit together with its water resource manager or utility that describes how the local unit will ensure that water resources are used wisely within its jurisdiction. The Strategy will include policies that motivate wise use of water by all customers, while ensuring also that sufficient revenues are raised to maintain and improve the water treatment and delivery system over time. Policies might include appropriate water pricing structures, water supply allocations, and measures for motivating reductions in water use during periods of moderate and severe water shortage. The Strategy also might include a public outreach and education program to continuously promote adoption of wise management practices.

Water Rationing: Compliance with a local unit's imposition of restrictions that will reduce demand for water to a maximum allowable quantity with a finite time interval (e.g.: gallons per person per day).

Water Supply Outlook: A summary of snowpack, reservoir, ~~stream flow~~ streamflow, and precipitation for watersheds and basins, which is available bi-monthly from January through April from the U.S. Department of Agriculture's National Resources Conservation Service.

Water Year: The water year begins on October 1 and ends on September 30 of the following year. For example water year 1994 began October 1, 1993 and ended September 30, 1994.

Watershed: The land area from which surface runoff drains into a stream, channel, lake, reservoir, or other body of water; also called a drainage basin.

Weather: Describes the daily conditions (individual storms) or conditions over several days (week of record-breaking temperatures) to those lasting less than two weeks.

Suggestions for additional terms & definitions for inclusion in the Glossary

Consumptive use: (to be determined by the WSTF)

Evapostranspiration – the transfer of water from the earth into the atmosphere by (1) evaporation from surface water and soil and (2) transpiration from vegetation.

Groundwater withdrawals – Physical removal of water from beneath the ground.

Surface drainage - The removal of excess surface water or ~~groundwater~~ ground water from land by means of ditches or subsurface drains, or by the flow patterns of storm water run-off over the land in its pre-development state.

Wastewater (Treated and Untreated)): Liquid or water-carried waste from industrial, municipal, agricultural, or other sources.

Water demand- Aggregate water use/needs by municipalities, industry, agriculture, etc. that are dependent upon population, weather, climate, water rates and conservation efforts.

Water shortage-- a limitation of the water supply resulting from natural phenomenon such as drought and problems of water distribution and use.

Water supply- Amount of surface and ground water available for designated uses (municipal, industrial, agricultural etc.).